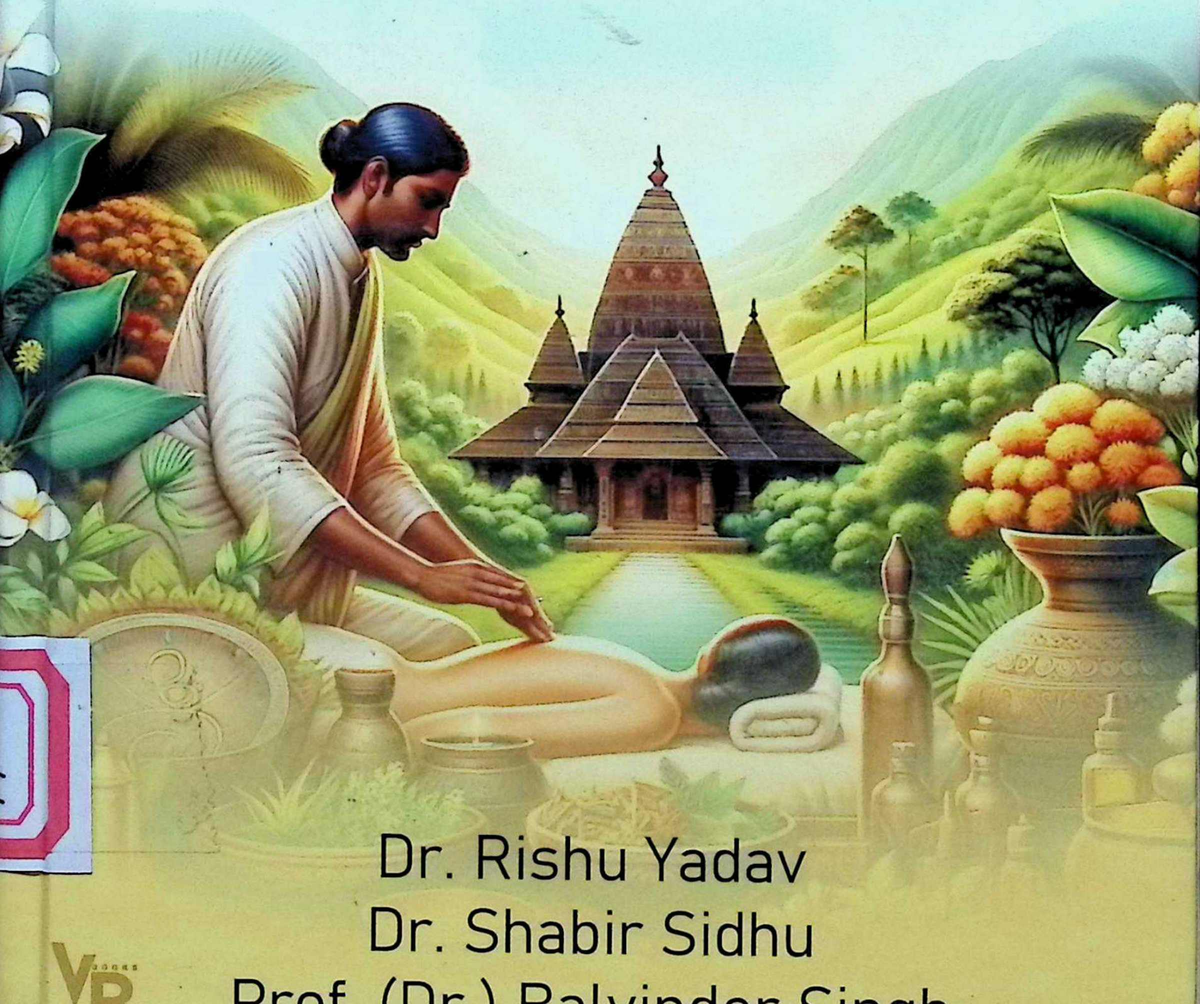
INDIAN MEDICINAL SYSTEM

From Ancient India to Modern Era



Dr. Rishu Yadav
Dr. Shabir Sidhu
Prof. (Dr.) Balvinder Singh

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From Ancient India to Modern Era

Dr. Rishu
Dr. Shabir
Prof. (Dr.) Balvi

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Indian Medicinal System: From Ancient India to Modern Era

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Edited by

Dr. Rishu Yadav
Dr. Shabir Sidhu
Prof. (Dr.) Balvinder Singh

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Foreword

Dear Authors & Readers,

It is my pleasure to present this authoritative and informative book "*Indian Medicinal System: From Ancient India to Modern Era*" and it shall be as an indispensable tool for all pharmacy professionals, students, and anybody who is interested in the exciting world of ancient knowledge of medicine and its application in modern era. In the increasingly dynamic healthcare environment, pharmacists have a determining role to play in guaranteeing the safe and effective administration of medicines. Not only does this textbook bring out the scientific basis for healthcare practice but also the context of its applicability in practice-based healthcare situations along with various ancient therapy of healing like Ayurveda, Homeopathic medicine, Unani system etc.

I congratulate the authors and contributors for their dedication and commitment in advancing pharmacy knowledge. This book would inspire future generations of healthcare professionals to continue striving for excellence in their practice and making meaningful contributions to the world of healthcare.

Thank you,

Dr. Nand Kishore Garg
Chancellor, Maharaja Agrasen University
Founder & Chief Advisor
Maharaja Agrasen Technical Education Society, Delhi.

MAHARAJA AGRASEN UNIVERSITY
NAAC ACCREDITED
Spark... The Change
Prof. (Dr.) R.K. Gupta
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Dated: 25th March, 2025

Foreword

It is important to acknowledge the profound influence of the Indian Knowledge System (IKS) in the pharmacy sector, especially as we integrate age-old wisdom with contemporary scientific methods. The principles of holistic health, natural remedies, and a comprehensive wellness approach are far from outdated; in fact, they are essential in addressing the changing demands of modern healthcare. This book entitled **"Indian Medicinal System: From Ancient India to Modern Era"** provides the platform aims to scholars, practitioners, and thought leaders to explore the intersection of traditional knowledge and cutting-edge pharmaceutical sciences. This book shall also help how Indian Knowledge System can shape the future of pharmaceutical industry and get the people aware about its applications in current scenario. It shall also attract readers to explore the depths of several historical medical systems and how they are used in contemporary situations.

We hope that the book will help to healthcare professionals for deep knowledge of Indian medicinal system and its history along with applicability in contemporary world

RkGupta

Prof. (Dr.) Rakesh Kumar Gupta
Vice-Chancellor

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Foreword

Dear Authors & Readers,

India's medicinal system has a legacy that dates back thousands of years, rooted in the principles of Ayurveda, Siddha, and Unani. These traditional healing practices, based on natural remedies, holistic wellness, and personalized treatment approaches, have been instrumental in shaping healthcare systems across the world. Over time, as modern medicine evolved with technological and scientific advancements, there has been a growing interest in integrating traditional wisdom with contemporary pharmaceutical innovations.

The transition from ancient Indian medicine to modern healthcare has been marked by extensive research, validation of traditional formulations, and the development of new therapeutics inspired by nature. Many modern pharmaceutical drugs derive their origins from ancient herbal remedies, highlighting the scientific relevance of India's medical heritage. Today, as the global healthcare landscape faces new challenges, the fusion of traditional knowledge with modern evidence-based medicine presents an opportunity for more effective and sustainable healthcare solutions.

This book brings together experts, researchers, and practitioners to explore the contributions of traditional Indian medicine in shaping modern pharmaceutical practices. By fostering interdisciplinary collaboration, we can bridge the gap between ancient wisdom and modern innovation, ensuring that the best of both worlds is harnessed for human well-being.

We hope that this book serves as a valuable resource, inspiring further research and policy discussions that will pave the way for a truly integrated and holistic healthcare system.

Prof. (Dr.) Susheel Mittal
Vice Chancellor
I.K. Gujral Punjab Technical University, Kapurthala

Foreword

In today's modern time, every person isrunning after money and other materialistic things of world like gold, bungalow, big car, apple mobile etc. etc.

The last epidemic Corona has taught mankind so many things. But the main crux of all teachings is that human health is the prime thing. The time has shown that people have plenty of money and other best treatments available but they are not able to save their near and dear. Most of the casualties were seen in developed countries, where people have good money and other best materialistic facilities.Ultimately this exposes the tall claims of modern allopathic treatment. The available modern drugs and treatments are not able to save huge loss of lives all over the world. At the time of crisis everybody talks of improvement of body immunity. Modern allopathy has limited choices.

Today's time is full of crisis, challenges in the field of medicine. People are full of stress and tensions in their life.It is a famous saying that in the event of crisis, the wise people look or search their basics. Same is the condition of mankind. At present they lose their hopes in modern allopathic system of medicine. Everybody is looking towards Indian Knowledge System (IKS). Indian Knowledge System had deep roots and such a vast ocean of sea of knowledge that, the mankind is not able to draw and explore even a bucket of drugs knowledge from Indian herbal drugs. There are millions of plants, which are useful as medicine. But their medicinal use is lost in the journey of time.

This book with the title "Indian Medicinal System:From Ancient India to Modern Era" is a joint and sincere effort of three popular, well renowned universities of India, to bring the lost glory of Indian herbal drugs value, back to its due place. In this holy expedition, this book will turn new leaf in the chapter of medicines from Indian herbs, plants of utmost medicinal usage.

Most of people are not aware of Indian Knowledge System, Indian herbs and medicinal plants. This book is just the beginning of a new era under the leadership of three Universities, who have a great vision and zeal to excel in putting the best efforts in holy Yagya of educating the people of India and World, in general and in course of time will be able to restore the lost throne of Indian drugs from Indian medicinal plants, in the mind of people and society.

I wish all the success to entire team and thanks the readers for making this beginning a well beginning, because it is a well -known fact that 'Well Beginning means Half the work Done'.

Prof. (Dr.) H.L. Verma
Vice Chancellor
Baba Mastnath University,
Asthal Bohar, Rohtak.

Preface

India possesses a varied and rich knowledge heritage system that stretches thousands of years into the past. These systems have contributed considerably to many areas of science and medicine, including pharmacy. The Indian knowledge system is vast and comprises several disciplines like Ayurveda, Siddha, Unani, and Yoga. These systems have profound philosophical, spiritual, and scientific foundations with a strong emphasis on holistic health, balance, and harmony in the body and mind. Significant works such as the Charaka Samhita, Sushruta Samhita, Ashtanga Hridayam, and Bhavaprakasha give in-depth information regarding medicinal plants, drug preparations, and the art of healing.

The history and holistic approach of the Indian knowledge system, as well as other historic medicinal systems like Ayurveda, homeopathic yoga therapy, medical astrology, etc., are covered in the book's fifteen chapters. This book also discusses the many plant sources and the way by which they can be used to treat conditions like thyroid, PCOD, hypertension, stress, anxiety, and more. It includes a plethora of information about planetary position-based treatment in the modern period, as well as descriptions of many ayurvedic therapies and formulations for medical use. This book combines the old Indian knowledge system with its contemporary application.

We hope, that this book will help the student and laymen to gain a practical understanding of the Indian knowledge system.

Editors
Dr. Rishu Yadav
Dr. Shabir Sidhu
Prof. (Dr.) Balvinder Singh

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A Systematic Review of Ayurvedic Preparation and Therapies: Principles, Practices, and Therapeutic Implications

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1.1 Introduction

Ayurveda is a traditional system of medicine that has been practiced for more than 5,000 years in India and other regions of South Asia. It is named after the Sanskrit terms "Ayur" (life) and "Veda" (knowledge) and is known as the "science of life." The central philosophy of Ayurveda is the harmony of the body, mind, and spirit and considers disease to be a consequence of disturbances in these components. Among the cornerstones of Ayurveda is the utilization of formulations — blends of plants, minerals, and occasionally animal products — individually adapted to individual constitutions or "doshas" (Vata, Pitta, and Kapha). This review aims to find out about Ayurvedic formulations, their structure, therapeutic indications, and safety considerations, in addition to difficulties they encounter under the framework of contemporary medical science (Parasuraman *et al.*, 2014).

1.2. Composition of Ayurvedic Formulations

Ayurvedic preparations consist of a large number of substances, and each is chosen on the basis of the particular healing quality it possesses. Ayurvedic preparations have been grouped into single-herb and multi-herb preparations, and they are applied in various forms like powders, pastes, tablets, oils, and syrups (Patwardhan *et al.*, 2017)

- **Herbs:** The most widely used ingredients in Ayurvedic preparations are medicinal plants. These plant materials are usually available in their natural form or processed in special methods to release their medicinal properties. They include Ashwagandha (Withania somnifera), Tulsi (Ocimum sanctum), and Triphala (an Ayurvedic preparation containing Amalaki, Bibhitaki, and Haritaki).
- **Minerals:** Certain preparations also contain minerals, which are said to have very strong therapeutic actions. Minerals that are most commonly used are Shilajit (a natural resin), Gold, Silver, and Mica, which are typically used in the purified form known as "Bhasma." Minerals are processed and prepared by certain specific Ayurvedic methods to make them more bioavailable and effective.
- **Animal Products:** Some Ayurvedic preparations include animal products, although this is not common at present because of ethical reasons. Ghee (butterfat) and milk are typical of substances that can be found in Ayurvedic preparations.
- **Other Ingredients:** Some preparations contain other compounds like honey, sugars, or salt, which are believed to enhance the bioavailability or activity of the herbal constituents (Joshi *et al.,* 2017)

1.3 SCIENTIFIC VALIDATION AND MODERN RESEARCH

Although Ayurveda has been practiced for millennia, recent years have seen substantial momentum in modern scientific proof of the efficacy of Ayurvedic preparations. Clinical trials and research studies have proven the effectiveness of numerous Ayurvedic drugs and preparations in curing a range of health ailments.For instance, research has demonstrated that Ashwagandha possesses strong adaptogenic activity, reducing cortisol and enhancing resistance to stress. Clinical trials for Triphala have revealed its therapeutic effects on gastrointestinal health, such as normalizing bowel movements and enhancing gut flora. Likewise, Boswellia has been demonstrated to possess anti-inflammatory activity, justifying its classical application in the management of arthritis and musculoskeletal disorders.But the quality of Ayurvedic research is still developing. Most studies have small sample sizes, short follow-up, or weak methodologies. There is also the issue of standardization, as Ayurvedic preparations are typically made with variations in ingredient procurement and preparation techniques (Pushpendra *et al.,* 2015).

1.4 Various Ayurvedic Formulations

Ayurveda, the traditional system of medicine originating from India, utilizes a variety of herbal formulations, oils, powders, and treatments to address different health concerns. These formulations are typically made from plant-based ingredients, minerals, and sometimes animal products, and they are customized to the individual's dosha (body constitution) and the condition being treated. Below are some common Ayurvedic formulations and their applications (Mukherjee *et al.,* 2017).

Chyawanprash

- **Ingredients:** A blend of herbs, spices, and fruits, including amla (Indian gooseberry), ghee, honey, and other herbal extracts.

Applications

- **Immune booster:** Known for its rejuvenating properties, it strengthens the immune system.
- **Improves digestion:** Helps in improving digestive fire (Agni).
- **Anti-aging:** Used to promote vitality, youthfulness, and general well-being.
- **Enhances cognitive function:** It may support mental clarity and memory.

Triphala

- **Ingredients:** A blend of three fruits – Amalaki (Amla), Haritaki, and Bibhitaki.

Applications

- **Digestive health:** Known for its mild laxative properties, Triphala supports digestion and regular bowel movements.
- **Detoxification:** Helps in cleansing the body of toxins and balancing the doshas.
- **Antioxidant properties:** Rich in antioxidants, it helps protect cells from oxidative damage.

Ashwagandha (*Withania somnifera*)

- **Ingredients:** The root of the Ashwagandha plant.

Applications

- **Adaptogen:** Helps the body adapt to stress and supports overall vitality.

- **Improves energy:** Known for its rejuvenating and energizing effects.
- **Reduces anxiety and stress:** It may help in reducing cortisol levels, thus promoting relaxation.
- **Supports cognitive function:** May enhance brain function and improve memory.

Brahmi (*Bacopa monnieri*)

- **Ingredients:** The herb Brahmi.

Applications

- **Brain tonic:** Enhances memory, concentration, and mental clarity.
- **Reduces stress:** Known for its calming effects on the nervous system.
- **Improves cognitive function:** Supports focus and mental sharpness.
- **Anti-anxiety:** May help in managing stress and anxiety levels.

Turmeric (*Curcuma longa*)

- **Ingredients:** The root of the turmeric plant, often used in powder form.

Applications

- **Anti-inflammatory:** Widely used to reduce inflammation and pain in the body.
- **Supports joint health:** Effective in treating arthritis and other joint issues.
- **Skin health:** Known for its antiseptic and skin-healing properties.
- **Boosts immunity:** Used as an immune-enhancing agent.

Neem (*Azadirachta indica*)

- **Ingredients:** Various parts of the neem tree, including leaves, bark, and oil.

Applications

- **Skin care:** Known for its antibacterial and antifungal properties, it is used to treat acne, eczema, and other skin issues.
- **Blood purifier:** Helps in detoxifying the blood and reducing impurities.

- **Anti-parasitic:** Used in treating internal parasites and fungal infections.
- **Supports liver health:** Assists in detoxifying and maintaining liver function.

Ghee (Clarified Butter)

- **Ingredients:** Cow's milk (typically), clarified and heated.

Applications

- **Digestive support:** Aids in enhancing digestion and absorption of nutrients.
- **Moisturizer:** Used externally for skin nourishment.
- **Anti-inflammatory:** Soothes inflammation when taken internally or applied externally.
- **Boosts mental clarity:** Supports brain function and overall vitality.

Shatavari (*Asparagus racemosus*)

- **Ingredients:** The root of the Shatavari plant.

Applications

- **Female reproductive health:** Traditionally used as a tonic for women's health, balancing hormones and enhancing fertility.
- **Supports lactation:** A well-known herb to increase milk production in nursing mothers.
- **Adaptogen:** Helps in managing stress and promoting relaxation.
- **Digestion support:** Useful in improving digestion and nourishing the body.

Haritaki (*Terminalia chebula*)

- **Ingredients:** The fruit of the Haritaki tree.

Applications

- **Digestive aid:** Used as a mild laxative to regulate bowel movements.
- **Detoxifier:** Helps cleanse the body and improve metabolic functions.
- **Enhances cognitive function:** Supports mental clarity and memory.
- **Boosts immunity:** Strengthens the immune system and helps fight infections.

Kumkumadi Tailam

- **Ingredients:** A blend of various herbs and oils, most notably saffron.

Applications

- **Skin care:** Helps in reducing blemishes, pigmentation, and improving overall skin tone.
- **Anti-aging:** Reduces wrinkles and promotes youthful skin.
- **Reduces dark circles:** Often used for under-eye care.
- **Enhances skin glow:** Used for rejuvenating the skin and giving it a radiant glow.

Saffron (*Crocus sativus*)

- **Ingredients:** The stigma of the saffron flower.

Applications

- **Skin care:** Helps reduce dark spots, pigmentation, and improves complexion.
- **Mood booster:** Known to promote feelings of happiness and reduce stress.
- **Anti-inflammatory:** Reduces inflammation and promotes general wellness.
- **Antioxidant:** Protects against oxidative stress.

Vidanga (*Embelia ribes*)

- **Ingredients:** The dried fruit of the Vidanga plant.

Applications

- Digestive health: Helps in treating digestive disorders like constipation and bloating.
- Parasite removal: Effective in eliminating intestinal worms and parasites.
- Detoxification: Aids in detoxifying the body by clearing out toxins.

Chandan (Sandalwood)

- **Ingredients:** The wood of the sandalwood tree.

Applications

- **Skin care:** Used to reduce skin inflammation, rashes, and acne.

- **Cooling agent:** Known for its soothing and cooling properties, often used in hot climates.
- **Anti-aging:** Reduces signs of aging such as wrinkles and fine lines.
- **Aromatherapy:** Used in meditation to calm the mind and reduce stress.

Under the guidance of a trained Ayurvedic practitioner who can recommend the appropriate dosages and combinations based on an individual's dosha and specific health conditions. Ayurveda, the traditional system of medicine originating in India, focuses on balancing the mind, body, and spirit. It uses natural remedies, dietary recommendations, and lifestyle modifications to treat and prevent diseases (Patwardhan *et al.*, 2009).

1.4 Therapeutic Applications of Ayurvedic Formulations

1.4.1 Digestive Disorders

- **Irritable Bowel Syndrome (IBS):** Ayurvedic treatments focus on balancing the digestive fire (Agni) with herbal remedies like *Triphala*, *Amla*, and *Shankhapushpi*. Diets that are easy to digest and warm, along with stress management, are also recommended.
- **Acid Reflux:** Herbs such as *Licorice* and *Amla* help in soothing the stomach lining and promoting better digestion. Avoiding heavy, greasy foods and incorporating *ghee* and *ashwagandha* can help manage acidity.

1.4.2 Respiratory Disorders

- **Asthma and Bronchitis:** Ayurveda suggests using herbs like *Tulsi* (holy basil), *Vasaka*, and *Brahmi* for their anti-inflammatory and bronchodilator effects. Nasal therapies like *Nasya* and breathing exercises like *Pranayama* are recommended.
- **Cough and Cold:** Herbal remedies like *Honey*, *Ginger*, and *Turmeric* help in reducing inflammation and clearing mucus. Steam inhalation with *Eucalyptus* or *Menthol* oil is also beneficial.

1.4.3 Cardiovascular Disease

- **High Blood Pressure:** Ayurveda suggests using *Arjuna* bark, *Ashwagandha*, and *Garlic* for their ability to regulate blood pressure. Lifestyle changes like stress management, yoga, and a heart-healthy diet are recommended.

- **Cholesterol and Atherosclerosis:** Herbs like *Turmeric*, *Triphala*, and *Guggul* help lower cholesterol levels and prevent plaque buildup in arteries.

1.4.4 Skin Disorders

- **Eczema and Psoriasis:** Ayurvedic treatments use topical applications like *Neem* paste, *Aloe Vera*, and *Turmeric* for their anti-inflammatory and healing properties. Internally, *Triphala*, *Amla*, and *Guduchi* are used to detoxify the body.
- **Acne:** Herbal treatments like *Neem*, *Tulsi*, and *Manjistha* are commonly used for their antimicrobial and purifying effects. A diet that reduces pitta (fire element) in the body is recommended.

1.4.5 Musculoskeletal Disorders

- **Arthritis (Osteoarthritis and Rheumatoid Arthritis):** Ayurvedic treatments focus on reducing inflammation and pain through the use of *Guggulu*, *Ashwagandha*, *Turmeric*, and *Bala*. External treatments like *Abhyanga* (oil massage) with specific herbal oils and *Panchakarma* detox therapies are also helpful.
- **Muscle Pain:** *Mahanarayan Oil* and *Bala Ashwagandha* are used to relieve muscle stiffness and pain.

1.4.6 Neurological Disorders

- **Parkinson's Disease and Multiple Sclerosis:** Ayurveda uses treatments to improve nerve function, reduce inflammation, and nourish the nervous system. *Ashwagandha*, *Brahmi*, *Vacha*, and *Shankhapushpi* are often used.
- **Anxiety and Depression:** Herbs like *Ashwagandha*, *Brahmi*, *Jatamansi*, and *Saffron* help in calming the nervous system. Meditation, yoga, and breathing exercises are also integral to the Ayurvedic approach.

1.4.7 Diabetes

- **Type 2 Diabetes:** Ayurveda uses herbs like *Guduchi*, *Fenugreek*, *Amla*, and *Bitter Melon* to regulate blood sugar levels. A proper diet and lifestyle changes focusing on maintaining balance in the doshas (body energies) are key to managing diabetes.

1.4.8 Endocrine Disorders

- **Hypothyroidism and Hyperthyroidism:** Ayurvedic herbs like *Ashwagandha* (for hypothyroidism) and *Guggul* (for hyperthyroidism) help balance thyroid function. Lifestyle modifications like stress reduction and proper sleep patterns are also emphasized.

1.4.9 Urinary Tract Disorders

- **Kidney Stones:** Ayurvedic treatments for kidney stones include *Varuna, Pashanbheda*, and *Coriander* seed decoction. Drinking plenty of water and maintaining a proper diet are also key in preventing kidney stone formation.
- **Urinary Tract Infections (UTI):** Herbs like *Coriander, Cinnamon*, and *Tulsi* have antimicrobial properties that help in treating UTIs.

1.4.10 Cancer Care

- **Complementary Cancer Treatment:** While not a primary treatment for cancer, Ayurveda supports cancer patients through immune-boosting herbs like *Turmeric, Ashwagandha, Guduchi*, and *Amla*. These herbs help with detoxification and managing side effects of conventional treatments like chemotherapy.

1.4.11 Obesity and Weight Management

- **Weight Loss:** Ayurveda approaches weight loss by balancing the doshas, improving digestion (Agni), and detoxifying the body. *Triphala, Guggul*, and *Garcinia* are used for fat metabolism and digestive health.
- **Metabolism Boost:** Herbs like *Cinnamon, Ginger*, and *Black Pepper* are known to enhance metabolism and aid in weight loss.

1.4.12 Women's Health

- **Menstrual Disorders:** For conditions like PMS, irregular periods, or menopause symptoms, herbs like *Shatavari, Ashoka, Turmeric*, and *Amla* are commonly used to balance hormones and promote menstrual health.
- **Infertility:** Ayurvedic treatments focus on restoring balance in the body, improving digestion, and enhancing overall health. Herbs like *Shatavari, Ashwagandha*, and *Tribulus* can improve fertility by supporting the reproductive system.

1.4.13 Liver and Detoxification

- **Liver Diseases:** Ayurvedic treatments for liver health include the use of *Kutki, Bhumyamalaki*, and *Guduchi*, which help cleanse the liver and improve its function.

- **Detoxification:** Panchakarma is an Ayurvedic detoxification therapy that involves a series of treatments aimed at cleansing the body of toxins, improving digestion, and restoring balance.

1.4.14 Chronic Fatigue Syndrome

Ayurveda aims to restore energy and vitality by strengthening the immune system, improving digestion, and reducing stress. Herbs like *Ashwagandha*, *Brahmi*, and *Ginseng* help combat fatigue and rejuvenate the body.

Ayurveda offers a variety of therapies that focus on restoring balance to the body, mind, and spirit. These therapies aim to address physical and mental health by detoxifying the body, enhancing vitality, and promoting overall wellness.

1.5 Various Ayurvedic Therapies

1.5.1 Panchakarma Therapy

Panchakarma is a detoxification and purification therapy that involves a series of five therapeutic treatments. It helps remove toxins (Ama) from the body, balances the doshas (Vata, Pitta, and Kapha), and rejuvenates the system (Suryawanshi.,2019). The five treatments in Panchakarma are:

- **Vamana (Emesis Therapy):** Induced vomiting to eliminate excess Kapha and toxins from the stomach and upper respiratory system.
- **Virechana (Purgation Therapy):** Cleansing the intestines and digestive system to remove excess Pitta and accumulated toxins.
- **Basti (Enema Therapy):** Medicated enemas are used to eliminate excess Vata and toxins from the colon and lower digestive tract.
- **Nasya (Nasal Administration of Medications):** Herbal oils or powders are administered through the nostrils to clear blockages, improve brain function, and treat conditions related to the head and sinuses.
- **Raktamokshana (Bloodletting Therapy):** Used to detoxify the blood by removing impurities and treating conditions like skin disorders, high blood pressure, and certain types of infections.

1.5.2 Abhyanga (Ayurvedic Oil Massage)

- **Description:** Abhyanga is a therapeutic full-body massage using warm herbal oils tailored to the individual's dosha (body constitution). It helps improve circulation, reduce stress, nourish the skin, and balance the doshas.

- **Benefits:** Enhances relaxation, promotes detoxification, rejuvenates the body, strengthens muscles, boosts immunity, and helps improve sleep.

1.5.3 Shirodhara

- **Description:** Shirodhara involves the gentle pouring of warm, medicated oil over the forehead, especially on the "third eye" area (between the eyebrows). It is commonly used in Ayurveda for stress reduction and mental clarity (Dwivedi *et al.,* 2012).
- **Benefits:** It calms the nervous system, relieves anxiety, improves sleep, boosts concentration, and helps treat conditions like insomnia and mental fatigue.

1.5.4 Swedana (Steam Therapy)

- **Description:** Swedana involves the use of herbal steam to open the channels of the body, expel toxins, and promote relaxation. The steam helps soften tissues and improve circulation.
- **Benefits:** Detoxifies the body, improves blood circulation, relieves muscle tension, alleviates joint pain, and supports the respiratory system.

1.5.6 Shiroabhyanga (Head Massage)

- **Description:** This therapy involves massaging the scalp with herbal oils to relax the mind and nourish the hair and scalp. It is typically accompanied by the use of oils like *Brahmi*, *Amla*, or *Bhringraj.*
- **Benefits:** Improves blood circulation to the head, alleviates stress and anxiety, enhances memory, and promotes hair growth.

1.5.7 Kati Basti (Spinal Therapy)

- **Description:** Kati Basti involves creating a reservoir of warm herbal oil on the lower back (lumbar region) to treat chronic back pain, sciatica, and other spinal issues. It is often used in cases of Vata imbalances.
- **Benefits:** Relieves lower back pain, improves flexibility, nourishes the spine and nervous system, and helps in treating conditions like herniated discs and muscle stiffness.

1.5.8 Udvartana (Herbal Powder Massage)

- **Description:** Udvartana is a stimulating herbal powder massage that uses a mix of medicinal powders (often including chickpea flour, herbs, and spices) to exfoliate the skin and promote circulation.
- **Benefits:** Helps with weight loss, reduces cellulite, improves blood circulation, rejuvenates the skin, and promotes lymphatic drainage.

1.5.9 Pinda Swedana (Herbal Bolus Therapy)

- **Description:** Pinda Swedana involves applying heated herbal boluses (bundles) filled with medicinal herbs to the body. These boluses are used to relieve pain, inflammation, and stiffness.
- **Benefits:** Effective for treating joint pain, arthritis, and muscle stiffness. It also improves circulation and reduces excess Kapha.

1.5.10 Nasya (Nasal Therapy)

- **Description:** Nasya therapy involves the administration of herbal oils or powders through the nostrils. It is used for cleansing the nasal passages, improving respiratory health, and enhancing mental clarity.
- **Benefits:** Helps treat sinusitis, allergies, headaches, and improves concentration and memory. It also balances the doshas, especially Vata (Varma *et al.,* 2022).

1.5.11 Kerala Speciality Treatments

- **Thalam:** A treatment where a mixture of herbs and oils is applied to the scalp, often combined with a massage. It is useful for calming the mind, treating mental fatigue, and addressing conditions like hair loss.
- **Lepanam:** A topical herbal paste is applied to the skin to treat various conditions such as psoriasis, eczema, and acne. The herbs used help reduce inflammation and improve skin health.

1.5.12 Ayurvedic Diet Therapy

- **Description:** Ayurveda emphasizes the importance of proper diet to maintain health and balance the doshas. Based on your dosha (Vata, Pitta, or Kapha), a specific diet plan is recommended.
- **Benefits:** Proper diet helps in digestion, metabolism, and detoxification. It is customized to restore balance to the body and prevent diseases.

1.5.13 Yoga and Meditation

- **Description:** Yoga and meditation are integral parts of Ayurvedic therapy. They are practiced to balance the body, mind, and spirit. Specific asanas (postures) are recommended to balance the doshas and improve overall health.
- **Benefits:** Yoga helps improve flexibility, strength, and stamina, while meditation reduces stress, improves mental clarity, and promotes emotional well-being (Agarwal *et al.,* 2014).

1.5.14 Basti (Medicated Enema Therapy)

- **Description:** Basti involves the administration of medicinal decoctions, oils, or herbal pastes into the rectum. It is one of the key treatments in Panchakarma and is particularly effective for Vata imbalances.
- **Benefits:** Relieves constipation, improves digestion, reduces bloating, and nourishes the lower gastrointestinal tract. It also balances Vata dosha and rejuvenates the body.

1.5.15 Rasayana Therapy (Rejuvenation Therapy)

- **Description:** Rasayana focuses on rejuvenation, improving vitality, and slowing down the aging process. It involves the use of rejuvenative herbs like *Amla*, *Ashwagandha*, *Shatavari*, and *Brahmi.*
- **Benefits:** Improves longevity, enhances immunity, boosts energy levels, and promotes overall health and vitality. It also helps in maintaining youthful skin and good mental health.

1.5.16 Jeevani (Vitality Enhancing Therapy)

- **Description:** Jeevani is a specific Ayurvedic therapy designed to strengthen and revitalize the body. It involves the use of tonics and rejuvenative herbs to improve overall well-being.
- **Benefits:** Strengthens the immune system, enhances vitality, and restores energy levels. It is often recommended for post-illness recovery (Gupta *et al.,* 2009)

1.6 Safety and Side Effects

The safety of Ayurvedic preparations is an issue, particularly when taken without professional guidance. Some of the possible risks involved in the use of Ayurvedic medicines are:

- **Toxicity:** Some preparations have the potential to carry heavy metals like lead, mercury, and arsenic, particularly if they are not made in accordance with traditional guidelines. For example, Rasa shastra, a sub-branch of Ayurveda concerned with mineral-based preparations, has been questioned due to misprocessing of metals.
- **Drug Interactions:** Ayurvedic drugs may interact with traditional drugs. Ashwagandha, for instance, might interact with drugs used to treat thyroid diseases, and Guggul might interfere with the absorption of some drugs (Rammanohar.,2019).
- **Quality Control Issues:** Unregulated and non-standardized preparation of Ayurvedic formulations might result in inconsistencies in the potency and safety of products.

For safety, it is important for people to see an Ayurvedic practitioner prior to using these preparations, especially if they are on other medications or have underlying health issues.

1.7 Challenges and Future Directions

Although Ayurvedic preparations hold promise, a number of issues need to be resolved in order to bring these practices into mainstream medicine.

- **Lack of Regulation:** There is a requirement for more stringent regulatory guidelines to ascertain the quality, safety, and efficacy of Ayurvedic preparations. The Ayurvedic industry remains mostly unregulated in most nations, and therefore there are variable standards.
- **Standardization of Products:** Since plant ingredients vary naturally, it is challenging to guarantee uniformity in formulation strength. Standardized extracts or preparations must be formulated to provide uniform therapeutic effects.
- **Research Gaps:** Though many studies have vindicated the therapeutic action of Ayurvedic products, the literature still lacks major clinical trials conducted on large patient populations. Increased research would confirm claims and also reveal mechanisms of action for Ayurvedic herbal drugs and preparations.

1.8 Conclusion

Ayurvedic preparations show vast potential to cure a plethora of health conditions through the process of reestablishing equilibrium among body systems. With a well-documented past, these Ayurvedic formulations are being accepted worldwide, particularly in the setting of preventative and holistic medicine. Safety, standardization, and scientific evidence still pose challenges despite the growing appreciation for these products. It would take future studies, regulatory enforcement, and measures of quality control to be able to incorporate these Ayurvedic formulations into present-day healthcare interventions. As the knowledge of such traditional remedies' advances, Ayurvedic formulations might provide useful substitutes or adjunct strategies to traditional medical interventions.

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2

Impact of Indian Herbs in Drug Development

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2.1 Introduction

The pharmaceutical sciences have seen remarkable progress worldwide, leading to lower mortality rates, increased life expectancy, and the discovery of numerous life-saving drugs to combat various infectious and chronic diseases. Advancements in technology have further expanded the potential of modern science. Plants contain a vast array of bioactive compounds, many of which have historically contributed to drug discovery and development. World Health Organization report says that about eighty percent of public are relying on medicine from herbal origin for primary healthcare, and ethnopharmacological sources account for 80% of the 122 plant-derived pharmaceuticals. Herbal medicines are valued for their compatibility with the human biological system and their relatively lower side effects. However, they are not as widely considered as synthetic drugs in modern pharmaceutical research. The pharmaceutical industry remains a key driver of global economic growth, with the herbal medicine market generating $50.9 billion in revenuesignificantly smaller than the synthetic drug market, which reached $934.8 billion in 2017. India's herbal medicine exports, which include Ayurveda, Unani, Siddha, and homeopathy (AYUSH) products, make up 3% of the country's pharmaceutical exports. Of these, 70% consist of raw materials, worth an estimated 10 billion rupees annually, while 30% are finished herbal products, such as extracts. However, India's overall contribution to the global herbal medicine market is hindered by challenges related to development, quality control, safety, efficacy, regulation, and limited interest from the medical community. This situation poses a financial burden for developing and low-income countries. This paper investigates the opportunities coupled with challenges linked with the development and commercialization of plant-derived drugs, along with potential future research directions (Vaidya and Devasagayam, 2007). Traditional systems of medicine are plant-based, but they were historically marginalized during the colonial era for being viewed as outdated and unscientific. However, with the advent of chemical analysis in the 19th century, scientists began isolating and modifying potent medicinal compounds from plants, leading to the development of modern allopathic drugs. Currently, around thirty percent of prescribed medicine comprise at least one active ingredient from plant origin. Recent studies suggest that herbal medicines can be as effective as conventional pharmaceuticals while maintaining a favourable safety profile. Plants naturally produce antimicrobial peptides as a defense mechanism, and these peptides have shown significant clinical potential due to their selective action against prokaryotes and their reduced likelihood of inducing microbial resistance (Fabricant and Farnsworth, 2001). Research on COVID-19 vaccines suggests that self-assembling peptide nanofibers could be an effective vaccine strategy. Additionally, advancements in genomics have enhanced herbal medicine research by identifying key gene clusters and duplication events linked to specialized metabolism. Understanding gene-metabolite relationships through genome sequencing, assembly, and annotation is crucial, as many bioactive plant compounds are secondary metabolites such as terpenoids, alkaloids, and phenolics. However, only a limited number of well-assembled herbal genomes have been published. Integrating genomic data with proteomic, transcriptomic, and metabolomic studies can help predict secondary metabolite pathways in medicinal plants. Plant-derived medicinal compounds are often referred to as "people's drugs" due to their accessibility, perceived safety, and simple preparation methods. As public opinion shifts in favour of natural medicines, they are gradually replacing conventional treatments in various countries. The resurgence of herbal products in recent years is driven by concerns over the side effects of synthetic drugs, the flop of existing treatments to treat chronic conditions, and the rise of antimicrobial resistance. According to WHO data, herbal medicine plays a crucial role in primary healthcare for 80% of the population in several Asian and African countries, while 70–80% of people in developed nations use complementary and alternative medicines (CAMs), which primarily consist of herbal products. In Japan, seventy percent of physicians of allopathic field are prescribing “Kampo” medicines (mainly herbal formulations), while over seventy percent of German physicians recommend plant-based treatments (Pan *et al,* 2013). In India, more than 70% of modern pharmaceuticals are derived from natural sources, with many synthetic drugs being modelled after plant-derived prototype compounds. Statistics show that natural substances are used in over 60% of cancer therapies currently available or under investigation. Additionally, eighty percent of immunosuppressive, antibacterial, anticancer and cardiovascular drugs are plant-based, and about seventy five percent of 177 approved anticancer drugs originate from natural compounds. Herbal medicine usage is widespread globally, 71% of Chileans and 40% of Colombians use herbal remedies, while complementary and alternative medicine is embraced by 46% of Australians, 49% of the French population, and 70% of Canadians. In the United States, approximately 158 million people use herbal or natural medicine. Throughout history, plants have remained the foundation of numerous ancient medical traditions and go on to play a meaningful role in contemporary drug discovery and healthcare (Hossain *et al.,* 2022). India is home to approximately seventeen to eighteen thousand species of flowering plants, of which an estimated 6,000–7,000 possess medicinal properties. These plants play a significant role in Indian culture and are documented in traditional systems of medicine (Ayurveda, Siddha, Unani, and Homeopathy). Around 960 medicinal plant species are actively traded, with 178 species having an annual consumption exceeding hundred metric tons. These medicinal plants serve as a crucial stock for the herbal industries while also providing income and healthiness safety to a sizeable population of India. Government of India has established the National Medicinal Plant Board (NMPB) to oversee the development, trade, conservation, and cultivation of medicinal plants in November 2000. NMPB is operating under the Department of AYUSH (Ministry of Health and Family Welfare), accountable for coordinating policies and programs aimed at promoting the sustainable growth of this sector (Samal, 2016).Medicinal plants derived natural products, documented in “Ayurveda and the Charak Samhita” have significantly played a role in drug discovery. Despite India’s vast biodiversity, much of its potential for discovering new chemical entities remains untapped. Though, plant-based drug discovery is a laborious and slow process. The established methodology is to focus on isolating a specific active compound from an extract and to develop a procedure to quantify it in crude drugs. There is prevailing notion based on examples like morphine, quinine, and digoxin that a specific active ingredient of drug extract is accountable for biological activity. However, this perspective overlooks potential synergistic or antagonistic interactions between multiple compounds in plant extracts. Studies have shown that the pharmacological effects of whole extracts often do not match those of isolated pure compounds, indicating the significance of multi-constituent interactions. Much of the recent research on medicinal plants revolves around rediscovering long-known effects at the levels of cells and molecules. Previous findings often lacked standardization, making it difficult to verify biological activity. Although traditional Indian medicine has been used for centuries to treat various ailments and syndromes, lacking systematic record regarding efficacy and safety of data. Negligence of the scientists is because of the intricacy of multiple constituent formulations and the uncertain mechanisms of action. In recent times, however, there has been a shift in drug discovery perspectives. The conventional "one disease-one drug" model is being reconsidered. Now, researchers are exploring polyherbal formulations for therapeutics and prophylaxis of multiple diseases. Scientifically validated and standardized herbs containing formulations could serve as cost-effective treatment options for several diseases. However, challenges remain in improving traditional Indian medicines, particularly in aligning them with global regulatory standards. Additionally, while Western phytomedicines are often targeted for specific conditions, Indian formulations are traditionally used for a wide range of ailments. This suggests an opportunity to adapt Ayurvedic and other Indian traditional medicines to a disease-specific framework for greater acceptance in modern healthcare. In response to this evolving landscape, India has launched new initiatives to rejuvenate discovery of drug from plants. In 1996, Council of Scientific and Industrial Research (CSIR) started a harmonized program comprising CSIR 19 laboratories of CSIR along with other research institutions to identify biologically active compounds from natural sources. A significant step in this direction is the Golden Triangle Partnership (GTP), a collaborative initiative between the CSIR, Indian Council of Medical Research (ICMR) and Department of AYUSH. The program aims to validate ayurvedic formulations and develop novel drugs. A latest information reveals that twenty out of thirty-eight ayurvedic formulations researched for eight disease conditions, presented for pre-clinical assessment to CSIR in the scheme of GTP (Sarmah, 2022). Despite these efforts, the Indian pharmaceutical industry has shown limited engagement in plant-based drug discovery, with most companies focusing on herbal formulations rather than isolating pure compounds.

The high costs associated with extracting and developing pure compounds from plants have made this a challenging investment. As a result, much of India's natural product research remains confined to academic institutions rather than full-scale commercial drug development (Nanbban and Kamraj, 2022). India lags Western nations in discovering new chemical compounds from plants. Many Indian medicinal plant compounds are continuingly studied and separated, as evidenced by the significant quantity of research publications from the institutions of Western countries. To bridge this gap, increased investment in research infrastructure, industry participation, and regulatory alignment are necessary to unlock India's full potential of drug discovery and development from herbal plants (Bhutani and Gohil, 2010). Drug discovery and development process from medicinal plants is displayed in fig 1.

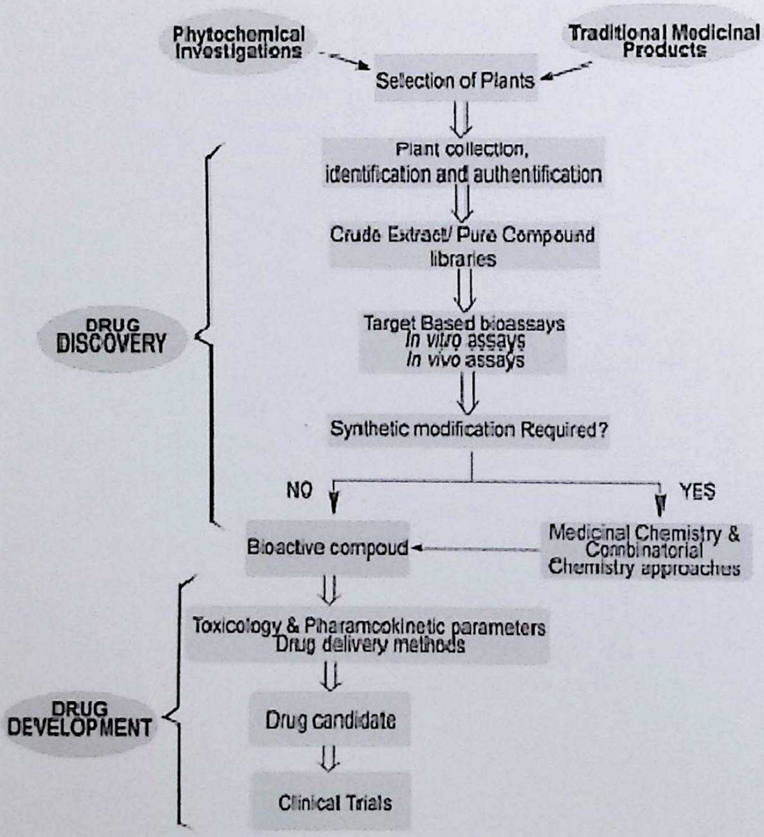
Phytochemical Investigations
Traditional Medicinal Products
Selection of Plants
Plant collection, identification and authentification
Crude Extract/ Pure Compound libraries
DRUG DISCOVERY
Target Based bioassays
In vitro assays
In vivo assays
Synthetic modification Required?
NO
YES
Bioactive compoud
Medicinal Chemistry & Combinatorial Chemistry approaches
Toxicology & Pharamcokinetic parameters
Drug delivery methods
DRUG DEVELOPMENT
Drug candidate
Clinical Trials

Fig. 1: Process of drug development from plants

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2.2 Methods of Discovery (Chaachouay and Zidane, 2024)

The process of discovering and developing therapeutics from plant-derived natural compounds is complex and multifaceted, involving several critical stages. Each step plays a key role in converting the prospective chemicals from plants into effective medicines. Detailed examination of these essential exploration processes is mentioned below (Fig 2).

Plant Collection

In the early phases of development of drug, ethnobotanists as well as botanists play a vital role in identifying and collecting plant species with potential therapeutic properties. The selection of plants is often directed by several persons, comprising traditional information provided by native and local populations. Additionally, ethnobotanical findings as well as ground assessments help pinpoint promising plant candidates. The collection of plant is a vital primary phase in gaining access to the assorted arrangement of biologically active chemicals realized inthe kingdom of plants.

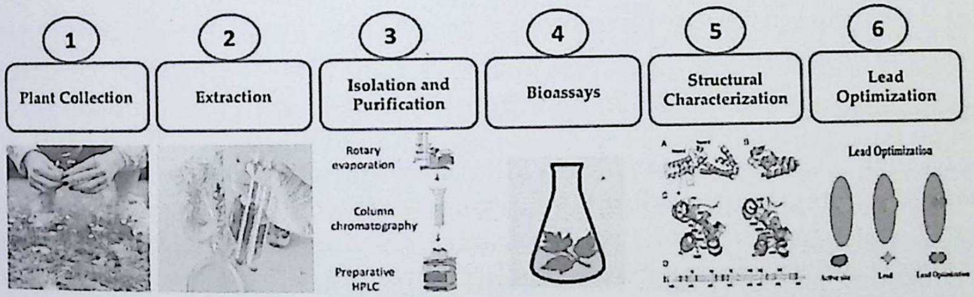
1
Plant Collection
2
Extraction
3
Isolation and Purification
4
Bioassays
5
Structural Characterization
6
Lead Optimization
Rotary evaporation
Column chromatography
Preparative HPLC
Lead Optimization
Lead

Fig. 2: Stages of drug discovery process from plants

Extraction

Once the plant material has been collected, the next step involves extracting biologically active chemicals from matrix of plant. The choice of method of extraction relies on the chemical characteristics of the compounds and the plant material's properties. Common processes comprise maceration, supercritical fluid extraction, and soxhlet extraction. Green extraction methods which are also called eco-extraction processes, help in reducing ill effects on environment and assist biologically active chemicals extraction. Other method of extraction, pressurized hot water extraction, depends on water solvent compared to organic solvents under raised temperature and pressure, though preserving the integrity of heat-sensitive biologically active chemicals. Even the research scientists are aiming to discover a biobased solvent which will be safer and secure for the human and environment. One of the likely alternates is ionic liquids salts which remain in a state of liquid at comparatively low temperature. These types of solvents are useful for various extraction applications because of high heat stability, less volatile in nature, and flexible properties. Other bio-based solvent is deep eutectic solvent, prepared from natural and renewable chemicals, for instance, amines and organic acids. These Discoveries of these solvents not only reduce ill effects on environment but also enhance safety and security of human population.

Isolation and Purification

Plant material's extract constitutes a mixture of biologically active and non-biologically active chemicals. There are processes such as fractionation and purification to get biologically active chemical or compound. Important techniques such as column chromatography and high-performance liquid chromatography are utilised in these processes for identification, separation, and quantification of compounds. Moreover, other approaches of purification such as solvent partitioning and crystallization can be exercised for advance refining of desired compounds.

Bioassays

Once compounds have been identified and purified, the subsequent essential step is assessing their pharmacological effectiveness. In this step, both in vitro and in vivo bioassays are performed to evaluate efficacy, safety, and possible mechanisms of action of compounds. In vitro experimentations occur in monitored environment of research laboratory by means of cell culturing techniques or parameters controllable instrument and equipment. In contrast, in vivo investigations comprise assessment in living beings, providing valuable information about their physiological effect and possible toxic effects.

Structural Characterization

Information about the chemical composition of biologically active compounds is necessary for knowing the characteristics and aptness for development as pharmaceuticals. Techniques such as Mass spectrometry and nuclear magnetic resonance spectroscopy techniques are generally exercised to analyze the separated chemical's structure. Such Techniques provide complete information about three-dimensional array of atoms and functional groups within the chemical molecules.

Lead Optimization

Separating the lead compound having favourable pharmacological activity now requires optimization. In this phase of drug development, chemist having medicinal knowledge along with pharmacologists During this phase, medicinal chemists and pharmacologists work together for improving the properties of compound. These researchers target on recuperating strength, pharmacokinetic characteristics, and selectivity through transformations in structure of compound. The chief goal is to design a molecule exhibiting potential as a therapeutic as well as meeting necessities of demanding efficacy and safety for the humans. The whole process of drug discovery and development pursues a organised and planned procedure. This process mixes traditional knowledge with technical, scientific, and logical procedures. Every step or phase is vital in developing medications of herbal nature in to life saving medicines.

2.3 Indian Herbs & Their Use

Besides the entrenched curative uses of medicinal plants of Indian origin, many have revealed efficiency in curing various other ailments. For instance, *Holarrhena antidysentrica* (the *kurchi* plant) has been customarily utilized to control dysentery. One of chief biologically active component, conessine (a steroidal alkaloid) is recognised for its anti-amoebic qualities. Though, the whole plant is studied safe for pharmaceutical use, but the separated component conessine is noxious. Likewise, *Andrographis paniculata* constitutes contains neoandrographolide, a component effective in bacillary dysentery. This plant is extensively employed in herbal medicine, but the separated active component not utilized as an individual pharmaceutical (Mohanraj *et al.*, 2018). List of some Indian herbs is mentioned in figure 3.

Another example is *Adhatoda vasica*, known for its anti-asthmatic properties, yet its bioactive alkaloid, vasicine, has not been classified as a remedy. Brahmi (*Bacopa monnieri)* has been traditionally exercised in increasing memory for centuries. However, while baccosides isolated from the plant exhibit pharmacological activity, they do not replicate the full cognitive benefits observed with the whole plant extract. Similarly, *Triphala*, a well-known Ayurvedic formulation used for digestive health and overall well-being, derives its efficacy from a combination of polyphenolics and tannins. Yet, when these individual components are tested separately, they fail to produce the same therapeutic effects as the complete formulation. These examples highlight the significance of synergistic interactions in herbal medicine, where whole-plant extracts or multi-ingredient formulations often demonstrate greater therapeutic potential than their isolated active compounds. Above mentioned examples, though not exhaustive, indicate that conventional medicinal plants hold significant clinical strength in their whole-plant shape rather than as isolated components. Therefore, research and pharmaceutical advancements should focus on developing improved formulations that maximize their therapeutic benefits across various conditions. Additionally, the standardization of herbal medicinal products requires further enhancement, with stricter quality control measures comparable to those applied in allopathic medicine (Bhutani *et al.*, 2010).

Plant/Herbal formulation	Chemical constituents	Biological activity/Indication
Adhatoda vasica	Vasicine, vasicinone	Bronchodilator
Euphorbia prostrata	Flavonoids	Piles
Cassia spp.	Sennosides	Constipation
Bacopa monnieri	Baccosides	Memory enhancer
Tylophora indica	Tylophorine	Bronchodilator
Triphala	Polyphenolics, Tannins	Bowel cleanser, general tonic
Holarrhena antidysentrica	Conessine	Antiamoebic
Asparagus adscendens	Asparanin A, Asparanin B, Sarasapogenin	Fertility enhancer
Asparagus racemosus	Shatavarin	Galactogogue, tonic
Ocimum sanctum	Monoterpenes, sesquiterpenes	Respiratory diseases, immunomodulatory
Glycyrrhiza glabra	Glycrrhizin	Antiulcer, anti-tussive
Aloe vera	Aloin	Demulcent, skin diseases
Tribulus terrestris	Protodioscin	Diuretic, anabolic, aphrodisiac
Trigonella foenum-graecum	Trigonellin	Anti-diabetic, lipid lowering
Withania somnifera	Withanolides	Immunomodulatory
Embelia ribes	Embelin	Anti-fertility
Pterocarpus marsupium	Liquiritigenin, isoliquiritigenin	Anti-diabetic
Tinospora cordifolia	Tinosporic acid, Cordifolioside	Immunomodulatory
Aegle marmelos	Aegelin, Marmelosin	Bowel diseases
Phyllanthus emblica	Polyphenolics, Tannins	Antioxidant
Centella asiatica	Asiaticoside	Memory enhancer
Garcinia cambogia	Hydroxycitric acid	Antiobesity
Psoralea corylifolia	Psoralen	Vitiligo
Areca catechu	Tannins	Antiobesity, anti-tussive
Gmelina arborea	Arboreol	Tonic, stomachic
Achyranthes aspera	Achyranthine	Diuretic
Antethum graveolens	Anethole	Digestive, carminative
Argyreia nervosa	Alkaloids	Aphrodisiac, fertility enhancer
Vitex negundo	Flavonoids	Antiinflammatory
Bahuhinia variegata	Flavonoids	Diarrohoea, piles
Boerrhavia diffusa	Boeravinones	Hepatoprotective
Cyperus rotundus	Monoterpenes, Sesquiterpenes	Antibacterial, antipyretic
Evolvulus alsinoides	Flavonoids	Bitter, tonic
Symplocos racemosa	Alkaloids	Gynaecological disorders
Eugenia jambolena	Anthocyanins	Anti-diabetic

Fig. 3: Indian herbs and their biological activity

2.4 Herbal Drug Formulation Development

Developing and developed countries have been utilizing remedies of herbal nature since thousands of years because of their lesser side effects, and the mounting unhappiness for synthetical medications. Oriental herbal medicine has distinct characteristics, treating patients with medicinal plant mixtures, whether as single herbs or multi-ingredient formulations. These traditional remedies incorporate medicinal ingredients derived from plants, minerals, and organic matter. Herbal medicines are produced using eco-friendly processes and renewable raw materials, offering economic benefits while ensuring that those involved in cultivation also profit. With thousands of medicinal plants thriving in diverse bioclimatic zones, India is often referred to as the "Emporium of Medicinal Plants." Medicinal plants continue to serve as a vital source of therapeutic compounds in both modern and traditional medicine. Research is increasingly focusing on evaluating the efficacy of plant-based pharmaceuticals used in traditional medicine, as they are cost-effective, generally have fewer side effects, and, according to the WHO, are relied upon by approximately 80% of the global population. The integration of herbal medicine into evidence-based medicine is a relatively recent development. However, applying Western pharmaceutical research methods to herbal medicine presents unique challenges. It is crucial to adopt systematic and rigorous research approaches while also considering the medical philosophies and practices that guide the use of traditional herbal medicines (Hossain *et al.*, 2022).

2.5 Future Aspects and India's Position

Researchers are putting efforts in preparing modern medicine not only for the treatment of illnesses but also encouraging total health and safety of individuals. These efforts also increase the life quality of persons. This shift underscores the importance of integrating traditional herbal medicine into modern healthcare systems. Incorporating traditional herbal practices into contemporary medicine offers numerous benefits, including mutual enhancement of both systems, increased healthcare knowledge, expansion of practitioner expertise, improved access to primary healthcare, and broader medical accessibility across society. However, several challenges hinder this integration. Fundamental differences between medicinal systems, concerns about spiritual and conceptual disparities, fears regarding the potential adverse effects of traditional preparations, and a lack of stringent regulations and standardization all pose obstacles. The increasing use of Ayurvedic and other herbal therapies demands a more systematic and scientifically rigorous approach to validate their efficacy and safety (Verma and Singh, 2008). The globalization and promotion of Indian traditional medicine require a strategic, well-structured approach to overcome these challenges. Countries like China have successfully modernized traditional medicine through government-supported initiatives such as good agricultural and manufacturing practices. India has also recognized the need for similar reforms to enhance the credibility and global reach of Indian system of medicines. Government of India has opened multiple laboratories for testing of drugs and augmented already prevailing facilities committed to Indian system of medicines. Since 2000, India has commenced latest rules and guidelines and adopted good manufacturing practices for herbal medicines. These initiatives have led to positive outcomes, as demonstrated by the US patent awarded to Artrex®, a polyherbal preparation developed for the cure of arthritis. Government of India, has started Department of AYUSH, which administers the guidelines, rules, quality assurance, development, and standardization of medicines of Indian systems for promoting them. Department of AYUSH has reviewed various guidelines to rationalise the authorising and exportation of Ayurvedic herbal medicines of ayurvedic origin and classifying them into nutraceuticals, cosmeceuticals, and extracts of herbs in 2010. Recognizing its significance in primary healthcare, the Indian government has integrated Ayurveda into the national healthcare system, further strengthening its acceptance and accessibility. In February 2013, standing report on customary healing, Indian medicine, assessed policies of the government focussed on uniting Indian systems of medicines into regular healthcare for enhancing their global acknowledgement as matching therapies. In this century, health sector has played a pivotal role in attracting international patients seeking herbal treatments, reinforcing India's reputation in traditional medicine. With globalization, there is a growing demand for natural healthcare solutions, particularly among aging populations in countries such as Japan, United Kingdom, United States of America, and several countries in European continent. As life expectancy increases, so does the need for safe and natural treatment options. India is well-positioned to meet this demand, as evidenced by the rising number of medical tourists seeking traditional herbal therapies. Approximately one and half million patients from nations such as the United Kingdom, United States of America, China, Sri Lanka, Canada, and Bangladesh are regularly travelling India for treatments based upon traditional medicines. This industry contributes around $1.8 billion in foreign exchange earnings, with projections estimating that by 2015, the market would expand to $3.96

billion, attracting 2.8 million health travellers. This trend highlights the growing global acceptance along with benefits of Indian systems of medicines. India's rich heritage in traditional medicine is further reinforced by its extensive repository of natural remedies. The "Materia Medica of India" documents around two thousand natural-origin medicines, including 400 derived from other sources such as animal and mineral, while the rest are bases on plants. Additionally, there is comprehensive data on formulations of Ayurvedic (500), Unani (500), and Siddha (200) systems in Traditional Knowledge Digital Library, accompanied by details on two hundred ninety-one medicinal plants utilized in customary therapies. This presents significant opportunities for developing new herbal products and formulations that can be marketed as nutritional supplements, nonprescription remedies, or prescription medicines. Both government and private healthcare institutions, along with licensed practitioners, continue to provide Ayurveda-based treatments in India. Herbal medicine has been valued for centuries for its safety and natural compatibility with the human body. With a well-established scientific foundation, Indian traditional medicine continues to offer effective plant-based treatments for a wide range of health problems. By integrating these ancient practices with modern scientific advancements and technology, medicinal plants and herbal products of India can play a decisive part in providing both primary and advanced healthcare solutions worldwide (Sen and Chakraborty, 2015).

2.6 Conclusion

Indian traditional herbal medicine is gaining global recognition, with many individuals integrating it with modern medical practices to address their health concerns. However, to enhance its credibility and acceptance, there is a need for rational formulation, rigorous standardization, and systematic monitoring, all supported by strong scientific evidence. Establishing scientific approach of Indian customary medicines from herbs requires a structured methodology, including the identification of medicinal resources and an in-depth understanding of their molecular mechanisms, which could facilitate new drug discoveries. Although existing research underscores the potential of Indian medicinal plants in drug development, numerous plant species remain unexplored and warrant further study. A scientifically validated and well-organized integration of Indian traditional systems of medicine (ISMs) into modern healthcare is crucial. This would not only safeguard the interests of the Indian population but also improve healthcare accessibility and promote the global advancement of natural medicine.

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3

From Roots to Remedies: Understanding the Role of Indian Knowledge in Herbal Extraction

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3.1 Introduction

Medicinal plants are used to make herbal medicines or are processed for research purposes. To prepare plants for research, they must be collected, identified, dried, and ground properly. Then, the active compounds are extracted, separated, and isolated. The quality and quantity of these compounds are also measured.In recent years, people have become more interested in using plants as medicine because they are natural, easy to find, affordable, and relatively safe. Herbal medicine can also be a good alternative when conventional medicine has too many side effects or doesn't work.Extraction is the process of separating the active compounds from plants, such as alkaloids and flavonoids, using a suitable solvent and method. Plants with high levels of phenolic compounds and flavonoids have antioxidant properties and can be used to treat age-related diseases.Several methods are used to extract medicinal plants, including maceration, infusion, and Soxhlet extraction. To separate and purify the active compounds, techniques like thin-layer chromatography, high-performance liquid chromatography, and gas chromatography are used.The most effective way to extract beneficial compounds from plants depends on several factors, including the type of plant, the solvent used, the solvent's pH and temperature, and the ratio of solvent to plant material. The intended use of the final product also plays a role.This study examined various methods for extracting, separating, and identifying the active compounds in medicinal plants, including the choice of solvent, extraction techniques, and phytochemical screening.

3.1.1 Factors to be considered in choosing extraction method

- **Heat stability:** If the plant material can withstand heat, methods like Soxhlet extraction or microwave-assisted extraction are used. Otherwise, maceration or percolation are preferred.
- **Solvent type:** Water-based extractions use maceration, while volatile solvents require percolation or Soxhlet extraction.
- **Cost:** Affordable drugs are extracted using maceration, while expensive ones use percolation.
- **Extraction time:** Maceration is suitable for long-duration extractions, while microwave- or ultrasound-assisted extraction are used for shorter periods.
- **Final volume:** Large-volume products like tinctures use maceration, while concentrated products use percolation or Soxhlet extraction.
- **Intended use:** Human consumption extracts are typically made using maceration, while experimental products may use other methods (Majekodunmi, S.O. *et al.,* 2015*)*.

3.2 Commonly Used Methods in the Extraction of Medicinal Plants

- **Maceration:** This method involves soaking coarsely powdered plant material (leaves, stem bark, or root bark) in a solvent for at least three days. The mixture is stirred periodically, and the solvent is separated from the plant material through filtration or decantation. The solvent is then evaporated to obtain the extract. This method is suitable for heat-sensitive plant materials (Ujang, Z.B. *et al., 2013)*.
- **Infusion:** This method is similar to maceration, but the plant material is ground into a fine powder and soaked in a solvent for a shorter period. The solvent can be hot or cold, and the method is suitable for extracting bioactive compounds that are easily soluble. The solvent-to-sample ratio is typically 4:1 or 16:1, depending on the intended use. This method is also suitable for preparing fresh extracts before use (Majekodunmi, S.O. *et al.,* 2015*)*.

- **Digestion:** This method uses moderate heat to extract bioactive compounds from plant materials. The powdered plant material is mixed with a solvent in a container, which is then placed over a water bath or in an oven at 50°C. The heat helps reduce the solvent's viscosity and enhances the extraction of secondary metabolites. This method is suitable for plant materials that dissolve easily.
- **Decoction:** This method involves hot water extraction, where a powdered plant material is mixed with water in a container. Heat is applied to speed up the extraction process, which typically lasts around 15 minutes. The solvent-to-crude-drug ratio is usually 4:1 or 16:1. Decoction is used to extract water-soluble and heat-stable compounds from plant materials.
- **Percolation:** This method uses a specialized apparatus called a percolator. The process involves:
  - Moistening powdered plant material with solvent.
  - Adding more solvent and letting it sit for 4 hours.
  - Transferring the mixture to the percolator and letting it sit for 24 hours.
  - Slowly dripping the solvent through the plant material.
  - Collecting the extract and filtering it.
- **Soxhlet Extraction:** This method uses a specialized apparatus called a Soxhlet extractor. The process involves:
  - Placing powdered plant material in a porous bag.
  - Heating the solvent in the bottom flask, causing it to evaporate and condense.
  - The condensed solvent flows into the extraction chamber, extracts the plant material, and then flows back into the flask.
  - The process repeats until the plant material is fully extracted.

  Soxhlet extraction is suitable for plant materials that are partially soluble in the chosen solvent and for materials with insoluble impurities. However, it's not suitable for heat-sensitive plant materials.
- **Microwave-Assisted Extraction:** This method uses microwave radiation to extract bioactive compounds from plants. It works by:
  - Using electromagnetic radiation to heat up the plant material and solvent.

  - Causing the solvent to penetrate deeper into the plant material.
  - Releasing the bioactive compounds from the plant material. This method is suitable for extracting flavonoids and uses polar solvents.
- **Ultrasound-Assisted Extraction:** This method uses high-frequency sound energy to extract bioactive compounds from plants. It works by:
  - Disrupting the plant cell walls and increasing the surface area for solvent penetration.
  - Releasing the bioactive compounds from the plant material.

This method requires the plant material to be dried, ground, and sieved before extraction (Ujang, Z.B. *et al.*, 2013*)*.

3.3 Phytochemical Screening Method

Phytochemical screenings are preliminary tests conducted to detect the presence of both primary and secondary metabolites in an extract. Several qualitative analyses described below have been used to detect the presence of alkaloids, flavonoids, tannins, saponins, flavones, sterols, terpenes, cardiac glycosides, protein, carbohydrates, and fats.

Tests for alkaloids

- **Dragendorff's test:** 1mL of extract was taken and placed into a test tube. Then 1mL of potassium bismuth iodide solution (Dragendorff's reagent) was added and shaken. An orange red precipitate formed indicates the presence of alkaloids.
- **Wagner's test:** 1mL of extract was taken and placed into a test tube. Then 1mL of potassium iodide (Wagner's reagent) was added and shaken. Appearance of reddishbrown precipitate signifies the existence of alkaloids.
- **Mayer's test:** 1mL of extract was taken and placed into a test tube. Then 1mL of potassium mercuric iodide solution (Mayer's reagent) was added and shaken. Emergence of whitish or cream precipitate implies the presence of alkaloids.
- **Hager's test:** 1mL of solution of an extract was taken and placed into a test tube. Then 1mL of saturated ferric solution (Hager's reagent) was added and shaken. Formation of yellow-colored precipitate indicates the existence of alkaloids (Wallis, T.E. *et al.*, 1989*)*.

Test for Glycosides

- **Bontrager's test (modified):** One gram of the crude extract was first weighed, placed into a test tube, and dissolved in 5mL of dilute hydrochloric acid. Then 5mL of ferric chloride (5%) solution was added. The mixture was shaken and placed over water bath. Then the mixture was allowed to boil for 10min, cooled, and filtered. Afterward, the mixture was then extracted again with benzene. Finally, equal volume of ammonia solution was added to benzene layer. Appearance of pink color indicates the presence of anthraquinone glycosides.
- **Legals test:** 1mL of an extract was taken, and then an equal volume of sodium nitroprusside was added followed by few quantity of sodium hydroxide solution and shaken. Formation of pink-to-blood-red precipitate signifies the existence of cardiac glycoside.
- **Keller–Killiani test:** 2mL of the extract was taken and diluted with equal volume of water. Then 0.5mL of lead acetate was added, shaken, and filtered. Again, the mixture was extracted with equal volume of chloroform, evaporated, and dissolved the residue in glacial acetic acid. Then few drops of ferric chloride added. Again, the whole mixture was placed into a test tube containing 2mL of sulfuric acid. Emergence of reddishbrown layer that turns bluish green implies the presence of digitoxose (Trease, G.E. *et al.,* 1986*)*.

Tests for Steroids and Triterpenoids

- **Libermann Burchard's test:** This method is utilized for an alcoholic extract. Extract need to dry out first through evaporation, then extracted again with chloroform.Add few drops of acetic anhydrites followed by sulfuric acid from the side of the test tube. Formation of violet to blue-colored ring at the junction of the two liquids indicated the presence of steroids.
- **Salkowski's test:** 1mL solution of the extract was taken and 2mL of chloroform was added, shaken, and filtered. Few drops of concentrated sulfuric acid were added to filtrate, shaken, and allowed to stand. Development of golden-yellow precipitate indicates the presence of triterpenes (DhawanD *et al.,* 2017*)*.

Tests for Tannins

- **Gold Beater's skin test:** A Gold Beater's Skin was obtained from Ox skin. The Gold Beater's Skin was soaked in 2% hydrochloric acid and washed with distilled water. Then it was placed in a solution of an extract for 5min and washed with distilled water. Finally, it was placed in 1% ferrous sulfate solution. If the Gold Beater's Skin changed to brown or black tannins is present.

- **Gelatin's test:** 1mL of extract was taken and placed in a test tube. Then 1% gelatin solution containing sodium chloride added and shaken. Appearance of white precipitate indicates the presence of tannins (Wallis, T.E. *et al.*, 1989).

Tests for Flavonoids

- **Shinoda's test:** 1mL of extract was taken and placed into a test tube. Then, few drops of concentrated hydrochloric acid was added pink coloration indicates the presence of flavonoids.
- **Alkaline reagent test:** 1mL of extract was taken and placed into a test tube. Then few drops of sodium hydroxide solution were added and shaken. Emergence of intense yellow color that turns to colorless after adding dilute acid implies the existence of flavonoids (Beena, P., *et al.* 2016).

Tests for Phenols

- **Ferric chloride test:** 1mL solution of an extract was taken and placed into a test tube. Then 1% gelatin solution containing sodium chloride was added and shaken. Formation of bluish-black color indicates the presence of phenols.
- **Lead acetate test:** 1mL solution of an extract was taken and placed into a test tube. Then 1mL of alcoholic solution was added, followed by dilution with 20% sulfuric acid. Finally, solution of sodium hydroxide was added. Formation of red-to-blue color signifies the occurrence of phenols.
- **Gelatin test:** A solution of plant extract was placed into test tube followed by 2mL of 1% gelatin solution and shaken. Appearance of white precipitate indicates the presence of phenols.
- **Mayer's reagent test (potassium mercuric iodide test):** To a solution of plant extract, 1mL of Mayer's reagent was added in an acidic solution. Manifestation of white precipitate shows the existence of phenolic compounds (Wallis, T.E. *et al.*, 1989).

Tests for Protein

- **Biuret test:** Some quantity of an extract was taken and 4% sodium hydroxide solution of the drug was produced. This is followed by the addition of 1% copper sulfite. Appearance of violet color implies the existence of peptide linkage.

- **Ninhydrin test:** 1mL of an extract was taken and placed into a test tube. Then 0.25% of ninhydrin reagent was added and shaken. The mixture was then boiled for few minutes. Formation of blue color signifies the presence of protein.
- **Xanthoproteic test:** 1mL of the extract was taken and placed it into a test tube. Then few drops of nitric acid were added and shaken. Emergence of yellow-color indicates presence of protein (Sofowora, A. *et al.,* 2018).

3.4 Fractionation and Purification Methods

Fractionation is a process of separation of plant extracts into various fractions. It further segregates the fractions into portions comprising a number of compounds. The process continues until pure compound is isolated (Banu K.S. *et al.,* 2015). When several solvents are required for the fractionation, they should be added according to the order of increasing polarity. Fractionation techniques are basically classified into physical or chemical method.

Physical Methods

Physical methods used in separation of compounds from mixtures include separation funnel method, chromatographic techniques, fractional distillation, fractional crystallization, fractional liberation, and sublimation.

- **Separation funnel method:** When four different solvents (*n*-hexane, chloroform, acetone, and *n*-butanol) are selected, fractionation begins by moistening or complete dissolution of crude extract with 250mL of water. This is followed by transfer into a separating funnel, shaken, and allowed to settle. Furthermore, to 250mL of *n*-hexane, the least polar solvent was added and shaken. The content can settle, and the bottom of the separating funnel opened to remove the aqueous layer. The remaining content in the separating funnel was poured into a clean container to get *n*-hexane fraction. Equal volume of *n*-hexane was added again, shaken, and separated. The addition continued until after adding *n*-hexane and shaken no reasonable quantity of extract appeared to move into the *n*-hexane portion. Similar cycle was performed for chloroform, acetone, *n*-butanol to get chloroform, acetone, and *n*-butanol fractions. The remaining portion left after the fractionation is termed as residual aqueous fraction (RAF) as the crude extract was first dissolved in water (Heftmann, F. *et al.,* 1992).

- **Fractional distillation:** This is a process of separating or purifying compounds from a mixture. It is usually used in separation of hydrocarbons such as crude oil, citral, and eucalyptol. Purification is achieved based on the differences in their boiling points. Fractional distillation apparatus is constructed in such a manner that when heat is applied each compound will evaporate and separates at its boiling point. Consequently, each compound fractionated will condense and collected as a separate entity through several siphons attached to fractional distillation apparatus.
- **Fractional crystallization:** Large numbers of compounds that exist naturally in plant extracts are crystal in nature. Separation is achieved via formation of crystals during concentration of an extract using heat or refrigeration.
- **Fractional liberation:** This method is suitable for separating compounds that can easily form precipitate from the mixture. The precipitate is usually formed by changing the compounds into their salt form. Fractional liberation is commonly applicable in purification cinnamon alkaloids.
- **Sublimation:** This method involves changing from solid to gaseous state without passing through liquid state. Substances such as camphor and volatile oils when heated get separated and converted directly into gas.
- **Chromatographic techniques:** These techniques separate compounds based on their size, shape, and charge. Common chromatographic techniques include:
    - Paper Chromatography (PC)
    - Thin Layer Chromatography (TLC)
    - Column Chromatography (CC)
    - Liquid Chromatography (LC)
    - Gas Chromatography (GC)
    - High-Performance Liquid Chromatography (HPLC) (Doughari J.H. *et al.,* 2012).

Mechanisms of Separation in Chromatography

- **Adsorption chromatography:** Separation is performed based on the interaction between compounds to be separated and the stationary phase. In this case, the stationary phase will pull and remove compounds via hydrophobic, non-covalent Van der Waals forces of attraction. The compound that is loosely bound will first be eluted by the mobile phase.

- **Partition chromatography:** Compounds are separated by addition of two or more immiscible solvents in to the mixture of an extract. Each compound will part away from the mixture by dissolving in the portion of solvent where it is soluble. Subsequently, the immiscible liquids will be separated using separating funnel to obtain the individual compounds. The partition chromatography is otherwise known as liquid/liquid separation.
- **Affinity chromatography:** The stationary phase is a ligand positioned in a separating column. The mobile phase applied washed down the compounds that have no affinity for the stationary phase. As such, compounds with high affinity for stationary phase get attracted and separated.
- **Ion exchange chromatography:** The concept of ion exchange is useful in separation of polar compounds based on the type of charge they possessed. As such like charges attract, whereas unlike charges repelled. Like-charge substances attracted to each other and get separated the mixture or extract.
- **Size exclusion chromatography:** This method considers separating compounds based on their molecular size by application of mesh of different diameters. It is also known as gel filtration or molecular sieving. A smaller size mesh was first applied followed by medium size, and finally larger pores size mesh (Rimando A.M. *et al.,* 2021).

Chromatographic Techniques Used in the Separation of Compounds from a Mixture or Extracts

- **Paper Chromatography (PC):** The mechanism of separation involved in adsorption chromatography. The apparatus comprises a glass chamber and a stationary phase, which is a filter paper made from cellulose. The filter paper is hanged from the top and suspended into the glass chamber. The mixture to be separated is placed at the bottom of the filter paper. In addition, the solvent is then poured into the bottom of the container to serve as a mobile phase. The mobile phase immediately begins to ascend along with the filter paper; separation is carried out by the upward movement of the mobile phase via capillary action. The compounds that are soluble will move together with the solvent and stick to the filter paper based on their solubility. The speed of separation depends on the type of filter paper used. Movement of liquid and the separation process is faster when thick filter paper is used, whereas porous filter paper slowed the whole process. Identification of each compound separated is done by calculating the retardation factor, which is the ratio of distance travelled by the compound to the distance travelled by the solvent. The advantages of this technique include simplicity and cost-effectiveness, very sensitive to small quantity of material. The disadvantages include time-consuming and fragility of paper, which can be destroyed by chemicals.

- **Thin Layer Chromatography (TLC):** This technique also involves the use of adsorption mechanism to separate a compound from a mixture. Separation is based on the interaction between the compounds in a mixture and stationary phase. It is applicable in the separation of compounds with low molecular weight. The stationary phase usually is 100g of silica gel dissolved in distilled water to make a slurry. Meanwhile, in some instances Sephadex is applicable. The solution of silica gel is then poured into a glass plate with dimension 20cm × 20cm to produce a thickness of 1.5mm. It is then kept for 1h at 105°C to solidify. Afterward, 10mL of extract is injected into the lower part of the plate and allowed to spread. The plate is then carefully inserted into the separation chamber containing mobile phase and allowed to stand for 30min. The compounds contained in the mixture will ascend to various positions on the plate based on their solubility. Each compound separated is identified by calculating its retardation factor which is the ratio of distance travelled by the compound to the distance travelled by the solvent and compare it with that of a known compound). The compounds spotted are scrapped at different position using spatula and finally re-extracted using various solvents. Advantages include less time-consuming, producing clear spots, and stable to acid as solvent.
- **Column Chromatography (CC):** It involves the use of several mechanisms such as adsorption chromatography, molecular sieve, and ion exchange to achieve the desired outcome. The column is made up of a long glass tube (5–50mm in diameter, 5 cm–1 m long) with a tap and glass wool filter at the bottom. In addition, silica gel, alumina, cellulose, or Sephadex are used as stationary phase, whereas the mobile phase is liquid. The process begins by packing 30g of silica gel (70/35) into a transparent glass column (80cm long, 5cm diameter) without introducing air bubbles. Subsequently, the extract to be partitioned is added from the top. Least polar solvent (*n*-hexane) was first added as a mobile phase and allowed to stand for 1h in

a closed column. The bottom of the column opened and various fractions of *n*-hexane collected at an interval. In addition to that, other solvents such as chloroform, ethyl acetate, *n*-butanol, and methanol added. Fractions of these solvents were collected individually at different time intervals and finally characterized.

- **Gas Chromatography (GC):** The mechanism implicated is partition. Two immiscible solvents are used: one in gaseous form (mobile phase) and the other is in liquid form adsorbed into the surface of inert solid to serve as the stationary phase. Substances that are soluble in the gaseous phase will leave the liquid, move to the gaseous phase, and get separated. Similarly, compounds that are soluble only in liquid form will remain in the stationary phase. Inert helium gas was used as mobile phase, at a constant flow rate. The crude extract to be analyzed was first diluted with methanol and injected into the system.
- **High performance LiquidChromatography (HPLC):** This technique uses the mechanism of adsorption to achieve effective separation. It is suitable for the partitioning of both organic and inorganic compounds. The mobile phase is a suitable solvent, whereas the stationary phase is solid particles tightly joined together. Separation is initiated via interaction of the compounds in the mixture with the solid particle of the stationary phase. The apparatus consists of a solvent reservoir, sample injector, pressure pump, HPLC tube, and diode detector. The process begins by injecting the mixture to be separated at the bottom of HPLC. In addition, a suitable solvent is poured into the solvent reservoir. The tap is now opened to allow the movement of solvent downward, which is then pushed by a pressure pump to mix up with the injected sample. Finally, the mixture moved into the diode detector, which separated the compounds, removed the waste, and pumped the final content to processing units (Ujang Z.B. *et al.,* 2013).

3.5 Identification Techniques

Several methods were used in the identification of compounds from medicinal plant extracts. It comprised detection of functional group, presence of multiple bonds and rings, hydrogen and carbon arrangement as well as full structural elucidation (Majekodunmi S.O. *et al.,* 2019). The techniques used include mass spectroscopy (MS), ultraviolet spectroscopy (UV), nuclear magnetic resonance spectroscopy (NMR), and infrared spectroscopy (IR).

- **MS:** This method is useful in the identification of compounds based on chemical structure and molecular weight. The aim is to sequence and identify the unknown compound in a mixture. The substances usually identified include oligonucleotides and peptides. The process begins by bombarding an organic molecule with an electron and converts it into very energetic charged ions. The signal was first detected using electron ionization energy of 70eV; also, the sample spectra are detected and recorded as percentage peak. Compounds are identified based on their relative molecular mass and molecular weight. This can be achieved by plotting mass of the fragmented ions against the charges of individual ion. Notably, MS provides abundant information on organic molecules. Therefore, one of the standard procedures in processing medicinal plant is the combination of MS/HPLC (Hossain, M.A. *et al.,* 2022*)*.
- **UV:** This method is suitable for qualitative and quantitative analysis of compounds present in the plant's extract. Various secondary metabolites such as phenols, anthocyanins, tannins, and polymer dyes could be detected at certain frequencies. Total phenolic content and other secondary metabolites can be established using this technique. Specific frequencies were used to identify flavonoids (320nm), phenolic compounds (280nm), anthocyanins (520nm), and phenolic acids (360nm) (Altemimi, A. *et al.,* 2017).
- **NMR:** This technique pays more attention to the physical properties of the bioactive molecule such as number and array of the carbon atom, presence of isotopes of carbon, hydrogen atom, and protons. It also described how atoms are arranged in a molecule (Hossain, M.A. *et al., 2022*).
- **IR:** This method tries to assess functional groups present in a compound. Knowledge of the functional group helps in defining the physical and chemical properties of a given compound. Also, single, double, and multiple bonds are identified through this process (Harborne, J.B. *et al., 2018*). The technique involves passing an organic compound through infrared radiation, which is absorbed in certain frequencies. Liquid samples are identified using sodium chloride plates, whereas solids samples are determined using potassium bromide milled together and compressed into a thin pellet. The result is recorded as a spectrum that is percentage transmittance. Lastly, the spectra are analyzed; the peaks obtained at certain wave number are compared with standard reference (M.V.S M.K. *et al.,* 2015).

3.6 Conclusion

Several works have been done on medicinal plant either to investigate and prove a reported claim of biological activity or to mimic its traditional medicinal use based on ethnomedicinal survey. Large numbers of medicinal plants have been extracted, fractionated, and compounds isolated successfully. In addition, compounds obtained were tested for biological or pharmacological activity, and in most cases, they were found to be active. Nonetheless, the rate of success and the authenticity of these findings depends on the accuracy in selection of solvents, selection and proper execution of extraction methods, phytochemical screening, fractionation, and identification techniques. Lastly, proper understanding and implementation of these techniques are indispensable. Advancement and modification of these methods periodically will ease research processes and improve the outcome.

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4

Yoga: An Alternative Path to Balance the Inner Peace

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4.1 Introduction

The surge in chronic diseases worldwide has prompted a renewed interest in complementary and alternative medicine (CAM) approaches, with yoga emerging as a prominent and increasingly popular practice. Yoga, derived from the Sanskrit root "yuj," meaning to unite or join, is a multifaceted discipline that originated in ancient India. It embodies a profound understanding of the interconnectedness between the physical body, mind, and spirit. The foundational texts of yoga, such as the *Yoga Sutras of Patanjali*, dating back several centuries BCE, outline a comprehensive system of ethical guidelines, physical postures, breathing exercises, and meditative practices designed to cultivate self-awareness, inner peace, and overall well-being (Iyengar, 1993).

Unlike many Western medical approaches that often focus on treating specific symptoms, yoga adopts a holistic perspective, addressing the root causes of disease by promoting balance and harmony within the individual (Ross & Thomas, 2010). This perspective aligns with the Indian Knowledge System (IKS), which emphasizes the interconnectedness of all aspects of existence and acknowledges the individual's inherent capacity for self-healing (Sharma, 2004). For thousands of years, the Indian Knowledge System (IKS) has provided deep understanding of the relationship between the body, mind, and spirit.Yoga, which is a holistic concept and practice that aims to achieve peace and well-being, is at the core of the practice.

Using its historical foundations in IKS, this book explores the therapeutic potential of yoga and how it can be used to prevent and treat a wide range of illnesses.

4.2 Indian Knowledge System (IKS)

IKS encompasses a diverse range of traditional disciplines encompassing philosophy, art, science, technology, and societal practices that have originated and evolved in India over millennia. These include:

- **Philosophy:** Darshanas like Sankhya, Yoga, Nyaya, Vaisheshika, Mimamsa, and Vedanta, which provide different perspectives on the nature of reality, consciousness, and liberation.
- **Ayurveda:** The science of life, focusing on holistic health and well-being through diet, lifestyle, and herbal remedies.
- **Vastu Shastra:** The science of architecture and design, promoting harmony between humans and their environment.
- **Jyotisha:** The ancient Indian system of astrology, offering insights into cosmic influences on human life.
- **Mathematics and Astronomy:** Significant contributions to mathematics, including the concept of zero and the decimal system, as well as sophisticated astronomical observations.
- **Languages and Literature:** Sanskrit, the mother of many Indian languages, along with rich literary traditions like the Vedas, Upanishads, Puranas, and epics like the Ramayana and Mahabharata.

4.2.1 IKS Enhances the Understanding of Yoga

The connections between Yoga and IKS are multifaceted and profound. Here are some key areas where IKS enhances the understanding and practice of Yoga:

- **Philosophical Foundation:** Yoga, as described in the Yoga Sutras of Patanjali, is fundamentally a philosophical system. Understanding the principles of Sankhya philosophy, particularly the concepts of Purusha (consciousness) and Prakriti (matter), is essential for grasping the core philosophy of yoga. Sankhya provides the framework for understanding the nature of suffering and the path to liberation (Kaivalya) that yoga aims to achieve.

- **Ethical Framework (Yamas and Niyamas):** The first two limbs of Ashtanga Yoga, Yamas (ethical restraints) and Niyamas (observances), are deeply rooted in the ethical and moral principles found in various IKS texts. Concepts like Ahimsa (non-violence), Satya (truthfulness), Asteya (non-stealing), Brahmacharya (celibacy/right use of energy), and Aparigraha (non-possessiveness) are not just rules but are integral to living a dharmic (righteous) life, a central concept in IKS.
- **Holistic Health and Ayurveda:** Ayurveda, the science of life, provides a complementary understanding of health and well-being that enhances the practice of yoga. Ayurveda emphasizes the importance of understanding one's individual constitution (Prakriti) and balancing the three doshas (Vata, Pitta, Kapha) to maintain health. This knowledge can be applied to personalize the practice of asanas, pranayama, and diet to suit individual needs and promote optimal health.
- **Pranayama and Subtle Energy (Prana):** Pranayama, the control of breath, is much more than just breathing exercises. It involves understanding the concept of Prana, the vital life force that permeates all living beings. IKS, particularly Tantra, provides detailed explanations of the Nadis (energy channels) and Chakras (energy centers) through which Prana flows. Understanding these concepts allows practitioners to consciously direct and balance Prana through pranayama, leading to increased vitality and spiritual growth.
- **Meditation and Dhyana:** Meditation (Dhyana) is a crucial aspect of yoga, leading to deeper states of awareness and self-realization. IKS provides various techniques and philosophies that enhance meditation practice. The concept of Samadhi, the ultimate goal of yoga, is deeply linked to the Vedantic understanding of the unity of Atman (individual self) and Brahman (universal consciousness).
- **Sanskrit and Mantras:** Sanskrit, the language of the Vedas and many other IKS texts, is considered a sacred language with powerful vibrations. Mantras, sacred sounds or syllables, are often used in yoga practice to focus the mind, purify the energy, and connect with divine energies. Understanding the

meaning and correct pronunciation of mantras, derived from IKS traditions, can deepen their effectiveness

We will navigate the intricate system of asanas (postures), pranayama (breathwork), meditation, and ethical principles, all underpinned by the foundational understanding of the human constitution as expounded in the Vedas, Upanishads, and other relevant scriptures. This approach emphasizes not just symptomatic relief, but also the cultivation of inner resilience and a proactive approach to health.

The IKS, encompassing fields like Ayurveda, Yoga, and Vedanta, provides a framework for understanding the human body as an integrated system governed by subtle energies and influenced by lifestyle factors, diet, and mental states (Frawley, 2000).

This review aims to explore the potential of yoga as a preventative and therapeutic modality for various diseases from an IKS perspective, incorporating contemporary scientific research to evaluate its effectiveness. We will delve into the philosophical underpinnings of yoga, examine the mechanisms through which yoga may exert its beneficial effects, and analyze the evidence supporting its application in managing prevalent health conditions. Furthermore, we will discuss the limitations of current research and identify areas for future investigation, emphasizing the importance of culturally sensitive and scientifically rigorous studies to fully understand and harness the therapeutic potential of yoga.

4.3 Indian Knowledge System And Holistic Approach of Yoga

IKS offers a unique lens through which to understand the principles and practices of yoga. Central to the IKS is the concept of *Prakriti* (nature) and *Purusha* (consciousness). Prakriti represents the material world, including the human body, composed of three fundamental qualities or *gunas*: *Sattva* (purity, harmony), *Rajas* (activity, passion), and *Tamas* (inertia, darkness). Purusha represents the pure, unchanging consciousness that observes Prakriti. Health, according to this perspective, is a state of balance within Prakriti and a clear connection to Purusha (Svoboda, 1992).

Yoga aims to restore this balance by harmonizing the body, mind, and breath. The *Yoga Sutras* outline the eight limbs of yoga (*Ashtanga Yoga*) Figure. 1, which provide a structured path towards self-realization and well-being.

4.3.1 The Eight Limbs Of Yoga (Ashtanga Yoga)

Yama (Ethical Restraints): These are moral principles that guide our interactions with the external world, fostering ethical behavior and responsible living. They include:

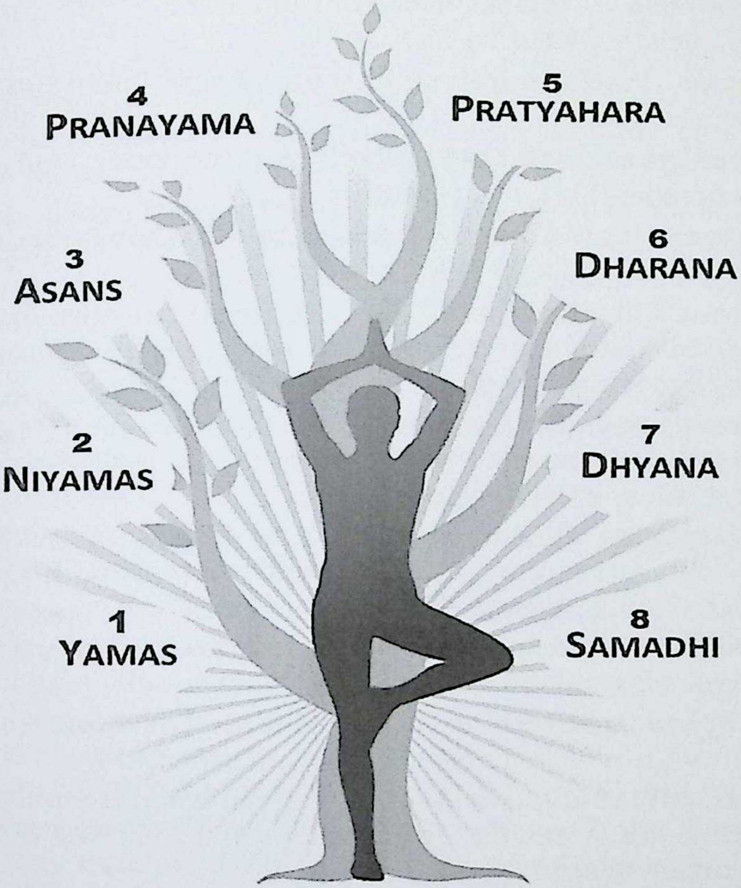
4
PRANAYAMA
5
PRATYAHARA
3
ASANS
6
DHARANA
2
NIYAMAS
7
DHYANA
1
YAMAS
8
SAMADHI

Fig. 1: Eight limbs of yoga

- **Ahimsa (Non-violence):** Compassion and kindness towards all beings.
- **Satya (Truthfulness):** Honesty in thoughts, words, and actions.
- **Asteya (Non-stealing):** Respecting the property and rights of others.
- **Brahmacharya (Continence/Moderation):** Conserving energy and practicing self-control.
- **Aparigraha (Non-attachment):** Letting go of greed and possessiveness.
- **Niyama (Observances):** These are positive habits and practices that cultivate inner discipline and self-improvement. They include:
- **Saucha (Purity):** Cleansing the body and mind.

- **Santosha (Contentment):** Cultivating gratitude and appreciating what we have.
- **Tapas (Self-discipline):** Burning away impurities through focused effort.
- **Svadhyaya (Self-study):** Exploring our inner landscape and understanding our true nature.
- **Ishvara Pranidhana (Surrender to a Higher Power):** Trusting in something larger than ourselves.
- **Asana (Physical Postures):** These postures cultivate strength, flexibility, and balance, preparing the body for deeper practices and promoting physical and mental well-being.
- **Pranayama (Breath Control):** Techniques that regulate the breath, influencing the flow of energy (prana) within the body and calming the nervous system.
- **Pratyahara (Withdrawal of the Senses):** Turning inward to cultivate inner awareness and disconnect from external distractions.
- **Dharana (Concentration):** Focusing the mind on a single point, developing mental clarity and stability.
- **Dhyana (Meditation):** Sustained focus and awareness, leading to a state of deep relaxation and inner peace.
- **Samadhi (Enlightenment):** A state of complete union with the divine, transcending the limitations of the ego and experiencing ultimate bliss.

The holistic approach of yoga, rooted in the IKS, recognizes that disease is not merely a physical ailment but a manifestation of imbalances at multiple levels. By addressing these imbalances through the various limbs of yoga, individuals can cultivate resilience, reduce stress, and enhance their overall well-being, thereby preventing and managing disease (Khalsa, 2004).

4.3.2 The Five Koshas (Sheaths)

Yoga, an ancient practice that originated in India, is not only a form of exercise but also a philosophical system that aims to understand the true nature of the self. One of the key concepts in yoga philosophy is the idea of the Five Koshas, or Five Sheaths Fig 2, which describe the different levels of being that make up an individual. These sheaths, or layers, are interconnected and interdependent, and each one represents a different aspect of our existence.

- **Annamaya Kosha:** The first kosha is the Annamaya Kosha, which is the physical body. This sheath is made up of the elements of earth, water, fire, air, and ether, and it is the densest and most tangible of the five sheaths. The Annamaya Kosha is nourished through food, sleep, and exercise, and it is the vehicle through which we experience the world.
- **Pranamaya Kosha:** The second kosha is the Pranamaya Kosha, which is the energy body. This sheath is made up of prana, or life force energy, and it is the vitality that animates the physical body. The Pranamaya Kosha is nourished through breathwork, meditation, and energy practices such as Reiki and Qigong.
- **Manomaya Kosha:** The third kosha is the Manomaya Kosha, which is the mental body. This sheath is made up of the mind and emotions, and it is the aspect of ourselves that experiences thoughts, feelings, and sensations. The Manomaya Kosha is nourished through practices that cultivate mindfulness, such as meditation, journaling, and therapy.
- **Vijnanamaya Kosha:** The fourth kosha is the Vijnanamaya Kosha, which is the wisdom body. This sheath is made up of our intuition, discernment, and understanding, and it is the aspect of ourselves that seeks truth and meaning. The Vijnanamaya Kosha is nourished through practices that cultivate self-reflection, such as philosophy, spiritual study, and self-inquiry.
- **Anandamaya Kosha:** The fifth kosha is the Anandamaya Kosha, which is the bliss body. This sheath is made up of pure consciousness and joy, and it is the aspect of ourselves that is in touch with our true nature. The Anandamaya Kosha is nourished through practices that cultivate inner peace, such as meditation, devotion, and service.

Understanding the Five Koshas is a powerful way to deepen our yoga practice, as it allows us to see ourselves as multi-dimensional beings with many layers of existence. By nourishing each sheath, we can create a balanced and harmonious relationship between the different aspects of ourselves, and we can experience a deeper sense of connection to the world around us.

The Five Koshas are an integral part of yoga philosophy, and they offer a framework for understanding the different levels of being that make up an individual. By exploring these sheaths, we can gain a deeper understanding of ourselves and the world, and we can cultivate a more balanced and harmonious way of being.

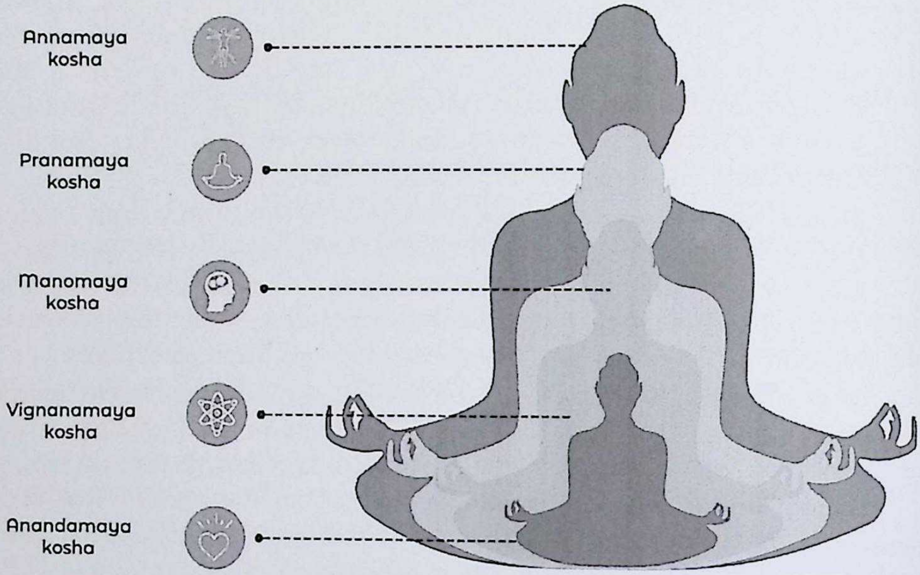

Fig. 2: Five koshas of yoga

4.4 Mechanism of Action: How Yoga Promotes Health

While the precise mechanisms through which yoga exerts its beneficial effects are still being investigated, several pathways have been identified that contribute to its therapeutic potential:

- **Stress Reduction:** Yoga has been shown to reduce levels of stress hormones, such as cortisol, and increase levels of relaxation-promoting hormones, such as GABA (gamma-aminobutyric acid) (Streeter *et al.*, 2007). Chronic stress is a major contributor to many diseases, including cardiovascular disease, mental health disorders, and autoimmune conditions. By mitigating stress, yoga can help prevent and manage these conditions.
- **Improved Cardio-Respiratory Function:** Yoga practices, particularly pranayama, can improve lung capacity, increase oxygenation of the blood, and lower blood pressure (Büssing *et al.*, 2012). These effects contribute to improved cardiovascular health and can be beneficial for individuals with respiratory disorders such as asthma and COPD.
- **Enhanced Musculoskeletal Health:** Asanas can improve flexibility, strength, and balance, reducing the risk of injuries and alleviating pain associated with musculoskeletal conditions

such as back pain, arthritis, and osteoporosis (Groessl *et al.,* 2008).

- **Regulation of the Nervous System:** Yoga can influence the autonomic nervous system (ANS), shifting the balance from the sympathetic nervous system ("fight or flight") to the parasympathetic nervous system ("rest and digest"). This shift promotes relaxation, reduces inflammation, and enhances immune function (Black & Slavich, 2016).
- **Improved Mental Well-being:** Meditation and mindfulness practices, integral to yoga, can reduce anxiety, depression, and improve cognitive function (Goyal *et al.,* 2014). These practices cultivate self-awareness, emotional regulation, and a sense of inner peace, which are essential for mental health.
- **Modulation of Inflammation:** Studies have shown that yoga can reduce levels of inflammatory markers, such as C-reactive protein (CRP) and interleukin-6 (IL-6) (Kiecolt-Glaser *et al.,* 2010). Chronic inflammation is a key driver of many diseases, including cardiovascular disease, cancer, and autoimmune disorders.
- **Gut Microbiome Modulation:** Emerging research suggests that yoga may positively influence the gut microbiome, the community of microorganisms living in the digestive tract. A healthy gut microbiome is crucial for immune function, nutrient absorption, and overall health (Bauer *et al.,* 2014).
- **Epigenetic Effects:** Preliminary studies suggest that yoga may influence gene expression, potentially leading to long-term health benefits (Bhasin *et al.,* 2013). Further research is needed to fully understand the epigenetic mechanisms of yoga.

These mechanisms highlight the multifaceted impact of yoga on physiological and psychological processes. By promoting balance within the body and mind, yoga can address the root causes of disease and contribute to overall well-being.

4.5 Yoga for the Prevention And Treatment of Specific Diseases

The evidence supporting the use of yoga for various health conditions is growing. This section will review the evidence for the application of yoga in managing cardiovascular diseases, respiratory disorders, musculoskeletal conditions, mental health issues, and metabolic syndromes.

4.5.1 Cardiovascular Diseases

Cardiovascular diseases (CVDs), including heart disease, stroke, and hypertension, are a leading cause of death worldwide. Yoga has shown promise as a complementary therapy for preventing and managing CVDs by addressing several risk factors, including high blood pressure, high cholesterol, obesity, and stress (Anderson *etal.*, 2005).

- **Hypertension:** Studies have demonstrated that yoga can reduce systolic and diastolic blood pressure in individuals with hypertension (Hagins *et al.,* 2013). Specific yoga practices, such as *Shavasana* (corpse pose) and *Pranayama*, have been shown to activate the parasympathetic nervous system, leading to vasodilation and a reduction in blood pressure.
- **Coronary Artery Disease:** Yoga-based cardiac rehabilitation programs have been found to improve exercise tolerance, reduce chest pain (angina), and improve quality of life in patients with coronary artery disease (Yadav *et al.,* 2010).
- **Heart Failure:** While more research is needed, some studies suggest that yoga can improve symptoms and quality of life in patients with heart failure (Evangelista *et al.,* 2015). Yoga may reduce sympathetic nervous system activity and improve cardiovascular function in these patients.
- **Hyperlipidaemia:** Several studies have reported that yoga interventions can lower LDL cholesterol ("bad" cholesterol) and triglycerides while raising HDL cholesterol ("good" cholesterol) (Innes *etal.*, 2005).

4.5.2 Respiratory Disorders

Yoga practices, particularly pranayama, are beneficial for individuals with respiratory disorders such as asthma, chronic obstructive pulmonary disease (COPD), and allergic rhinitis (Singh *etal.*, 2001).

- **Asthma:** Yoga can improve lung function, reduce airway hyperreactivity, and decrease the frequency and severity of asthma attacks (Cooper *et al.,* 2012). Specific pranayama techniques, such as *Bhastrika* (bellows breath) and *Kapalabhati* (skull shining breath), can help clear the airways and improve respiratory muscle strength. However, these techniques should be practiced with caution and under the guidance of a qualified instructor.
- **COPD:** Yoga can improve exercise capacity, reduce breathlessness, and enhance quality of life in patients with

COPD (Cramer *etal.*, 2014). Yoga may also help reduce anxiety and depression, which are common in individuals with COPD.

- **Allergic Rhinitis:** Studies have shown that yoga can reduce nasal congestion, sneezing, and other symptoms of allergic rhinitis (Jahnke *et al.,* 2009). Yoga may modulate the immune response and reduce inflammation in the nasal passages.

4.5.3 Musculoskeletal Conditions

Yoga is increasingly recognized as an effective therapy for managing musculoskeletal conditions such as back pain, arthritis, and osteoporosis (Bussing *et al.,* 2012).

- **Back Pain:** Numerous studies have demonstrated that yoga can reduce pain and improve function in individuals with chronic low back pain (Holtzman & Beggs, 2013). Specific yoga postures can strengthen core muscles, improve flexibility, and reduce muscle tension, alleviating back pain.
- **Arthritis:** Yoga can reduce pain, stiffness, and improve range of motion in individuals with osteoarthritis and rheumatoid arthritis (Kolås *et al.,* 2014). Yoga practices are generally modified to accommodate individual limitations and avoid exacerbating symptoms.
- **Osteoporosis:** Yoga can improve bone density and reduce the risk of fractures in individuals with osteoporosis (Lu *et al.,* 2016). Weight-bearing yoga postures stimulate bone formation and improve balance, reducing the risk of falls.

4.5.4 Mental Health Issues

Yoga has been shown to be effective in managing a range of mental health issues, including anxiety, depression, post-traumatic stress disorder (PTSD), and insomnia (Goyal *et al.,* 2014).

- **Anxiety:** Yoga can reduce anxiety symptoms and improve overall well-being in individuals with generalized anxiety disorder (GAD) and other anxiety disorders (Bussing *et al.,* 2012). Yoga practices promote relaxation, reduce stress hormones, and cultivate mindfulness, helping individuals manage anxiety.
- **Depression:** Yoga can alleviate depressive symptoms and improve mood in individuals with mild to moderate depression (Cramer *et al.,* 2013). Yoga may increase levels of neurotransmitters such as serotonin and dopamine, which are associated with improved mood.
- **PTSD:** Yoga can help reduce symptoms of PTSD, such as intrusive thoughts, flashbacks, and hyperarousal (van der Kolk

et al., 2014). Yoga practices promote body awareness, emotional regulation, and a sense of safety, helping individuals process trauma.

- **Insomnia:** Yoga can improve sleep quality and reduce insomnia symptoms (Ross & Thomas, 2010). Yoga practices promote relaxation and reduce stress, making it easier to fall asleep and stay asleep.

4.5.5 Metabolic Syndromes

Metabolic syndrome is a cluster of conditions, including obesity, high blood pressure, high blood sugar, and abnormal cholesterol levels, that increase the risk of heart disease, stroke, and type 2 diabetes. Yoga has shown potential for preventing and managing metabolic syndrome by addressing these risk factors (Vempati *et al.,* 2009).

- **Obesity:** Yoga can promote weight loss by increasing physical activity, reducing stress-related eating, and improving body awareness (Cramer *et al.,* 2016).
- **Type 2 Diabetes:** Yoga can improve blood sugar control, reduce insulin resistance, and lower the risk of complications associated with type 2 diabetes (Innes & Bernstein, 2015).
- **High Blood Sugar:** Yoga, especially when combined with dietary interventions, has shown to improve blood glucose levels (Muniyappa *et al.,* 2011).

4.6 Challenges and Limitations

Despite the growing body of evidence supporting the therapeutic benefits of yoga, several challenges and limitations need to be addressed:

- **Methodological Rigor:** Many studies on yoga are limited by small sample sizes, lack of control groups, and inadequate blinding (Ross & Thomas, 2010). More rigorously designed randomized controlled trials (RCTs) are needed to confirm the effectiveness of yoga for various health conditions.
- **Variability in Yoga Styles:** There are numerous styles of yoga, each with its own emphasis and techniques. This variability makes it difficult to standardize yoga interventions and compare results across studies (Bussing *et al.,* 2012).
- **Cultural Sensitivity:** Many yoga studies are conducted in Western populations, and the results may not be generalizable to other cultures. Culturally sensitive research is needed to adapt yoga interventions to the specific needs and preferences of diverse populations.

- **Adherence:** Maintaining long-term adherence to yoga practice can be challenging, particularly for individuals with chronic health conditions. Strategies to improve adherence, such as incorporating yoga into daily routines and providing ongoing support, are needed.
- **Safety:** While yoga is generally considered safe, injuries can occur, particularly if practiced improperly. It is essential to practice yoga under the guidance of a qualified instructor who can adapt the practice to individual needs and limitations.
- **Lack of Standardization:** The lack of standardization in yoga teacher training and certification can lead to inconsistencies in the quality of instruction. Establishing clear standards for yoga teacher training is crucial to ensure the safety and effectiveness of yoga interventions.
- **Limited Understanding of Mechanisms:** While several mechanisms of action have been identified, the precise pathways through which yoga exerts its beneficial effects are still not fully understood. Further research is needed to elucidate the underlying biological and psychological mechanisms of yoga.

4.7 Future Directions

Future research should focus on addressing the limitations identified above and exploring new avenues for investigating the therapeutic potential of yoga:

- **Large-Scale RCTs:** Conducting large-scale RCTs with rigorous methodologies is essential to confirm the effectiveness of yoga for various health conditions. These trials should include diverse populations and standardized yoga interventions.
- **Comparative Effectiveness Research:** Comparing the effectiveness of yoga to other treatments, such as conventional medical therapies and other CAM approaches, can help determine the optimal role of yoga in healthcare.
- **Mechanistic Studies:** Investigating the underlying biological and psychological mechanisms of yoga can provide a deeper understanding of how it exerts its beneficial effects. This research should include studies of gene expression, neuroendocrine function, and the gut microbiome.
- **Personalized Yoga Interventions:** Developing personalized yoga interventions based on individual needs, preferences, and health conditions can maximize the therapeutic benefits of yoga.

- **Technology-Based Yoga:** Exploring the use of technology, such as mobile apps and online platforms, to deliver yoga interventions can increase accessibility and adherence.
- **Integration of IKS principles:** Future research on yoga should explicitly draw upon the principles of the Indian Knowledge System (IKS) to provide a more holistic and culturally relevant understanding of its therapeutic potential. This includes considering the role of diet, lifestyle, and mental attitude in promoting health and well-being.
- **Cost-Effectiveness Analyses:** Assessing the cost-effectiveness of yoga interventions can help inform healthcare policy and promote the integration of yoga into mainstream healthcare systems.

4.8 Conclusion

Yoga, rooted in the ancient Indian Knowledge System, offers a holistic approach to health and well-being that has the potential to prevent and treat a wide range of diseases. The evidence supporting the therapeutic benefits of yoga is growing, particularly for cardiovascular diseases, respiratory disorders, musculoskeletal conditions, mental health issues, and metabolic syndromes. While challenges and limitations remain, future research should focus on addressing these issues and exploring new avenues for investigating the therapeutic potential of yoga. By integrating yoga into mainstream healthcare, we can empower individuals to take control of their health and cultivate a more balanced and fulfilling life. The key to successful integration lies in a nuanced understanding of yoga's philosophical foundations, practical applications, and potential contraindications, informed by both IKS principles and rigorous scientific inquiry.

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5

Ancient Ayurvedic Texts and Their Impact on Modern Pharmacology

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5.1 Introduction

Originating in the Indian subcontinent, Ayurveda is one of the world's oldest medical systems and has been used for more than 5000 years. Ayurveda is founded on a comprehensive approach to health and illness treatment, with roots in natural healing concepts. The approach uses the balance of the three basic biological energies—Pitta, Kapha, and Vata—that control bodily physiological processes to categorize health and illness. In contrast to traditional medicine, Ayurveda places a strong emphasis on lifestyle changes, prevention, and the therapeutic use of natural materials like metals, minerals, and plants (Pandey, Rastogi and Rawat, 2013). Classical works including the Charaka Samhita, Sushruta Samhita, Ashtanga Hridayam, and Rasashastra treatises have detailed documentation of ancient Ayurvedic knowledge. Thousands of medicinal plants, formulas, and treatment techniques are described in detail in these writings. The basis for comprehending plant-based medicine is laid by studying Dravyaguna Vigyan (Ayurvedic pharmacology) in these texts. Each herb is categorized according to its taste (Rasa), potency (Virya), post-digestive impact (Vipaka), and distinct action (Prabhava). Furthermore, books like Rasashastra emphasize the medicinal use of metals and minerals like sulfur, gold, and mercury, which are still relevant in contemporary metallopharmaceuticals. Ayurveda has been well-known around the world in recent decades because of its possible contributions to contemporary pharmaceuticals (Shilpa and Venkatesha Murthy, 2011; Jaiswal and Williams, 2017). Phytochemical and pharmacological studies of several Ayurvedic plants and formulations have identified bioactive substances with therapeutic qualities. Prominent examples are berberine from Daruharidra (Berberis aristata), withaferin from ashwagandha (Withania somnifera), and curcumin from turmeric (Curcuma longa), all of which have important medicinal properties like anti-inflammatory, adaptogenic, and antibacterial properties (Srivastava and Rawat, 2013). Additionally, the polyherbal approach of Ayurveda, which highlights the combined effects of many herbs in a formulation, is consistent with contemporary pharmacological combination medication therapy. Furthermore, pharmacogenomics, nanotechnology (Ayurvedic Bhasma research), and green chemistry concepts are being investigated from an Ayurvedic perspective, providing new avenues for personalized treatment and medication development. Therefore, there is a chance to create new treatment approaches by fusing Ayurvedic knowledge with contemporary scientific discoveries. The significant influence of ancient Ayurvedic writings on contemporary pharmacology will be examined in this chapter, with particular attention paid to their contributions to drug development, the standardization of herbal medicine, and future research avenues (Parasuraman, Thing and Dhanaraj, 2014; Vedarethinam and Jeevanandam, 2024).

5.2 Major Ancient Ayurvedic Texts and Their Contributions

5.2.1 Charaka Samhita (2nd Century BCE)

One of the most important ancient Ayurvedic writings is the Charaka Samhita, which mostly discusses internal medicine, or Kaya Chikitsa. It is credited to Acharya Charaka, who methodically recorded Ayurvedic principles, illness treatment, and herbal formulas. It is thought to have been assembled somewhere in the second century BCE. This work, which emphasizes a holistic approach to health, illness prevention, and natural treatment, forms the basis of Ayurvedic pharmacology and therapies(Ninama, 2024)life science. Charaka Samhita is a knowledge of encyclopedia comprehensive and provides an approach to Ayurveda. The time period of Charaka Samhita is considered to in between 1500 BC to 2nd century AD. The context of the treatise was first thought by Atreya and then subsequently codified by Agnivesha revised by Charaka later reconstructed by Drudhabala. As per the evidence, 12,000 verses are documented but presently 9295 verses are available in Charaka Samhita. To sum up, the Ayurvedic notion of the three Sutras—Hetu (reason.

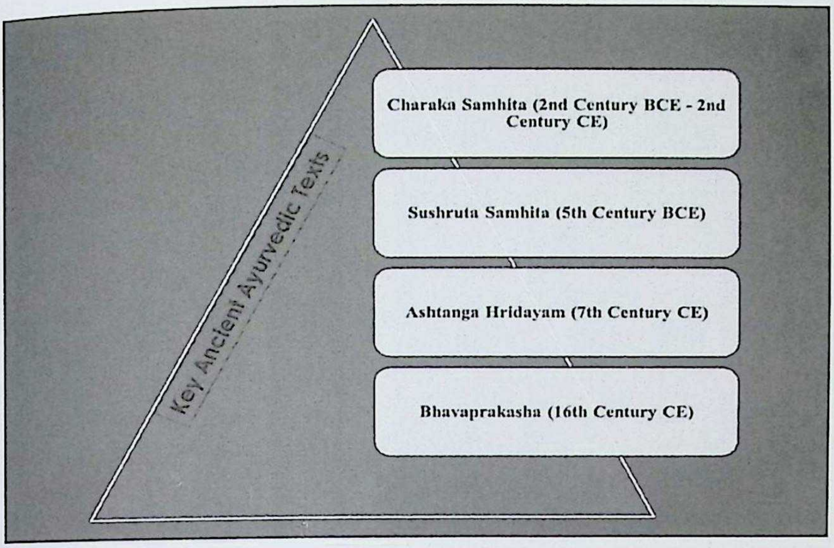
Key Ancient Ayurvedic Texts
Charaka Samhita (2nd Century BCE - 2nd Century CE)
Sushruta Samhita (5th Century BCE)
Ashtanga Hridayam (7th Century CE)
Bhavaprakasha (16th Century CE)

Fig. 1: Some Ancient Ayurvedic Texts

5.2.2. Principles of Internal Medicine (Kaya Chikitsa)

Kaya Chikitsa, or the treatment of systemic illnesses affecting the body, is introduced in the Charaka Samhita. It highlights the Tridosha Theory: The secret to preserving health is the harmony of Vata, Pitta, and Kapha. Diseases result from imbalances in these doshas. Etiology of Disease (Nidana) The etiology, pathophysiology, and prognosis of illnesses depending on lifestyle, environmental, and nutritional variables are described in the text. Customized Healthcare According on a person's Prakriti (body constitution), age, strength, and digestion, it recommends tailored treatment plans. This idea is consistent with contemporary pharmacogenomics. Rasayana Therapy employs dietary advice and medicinal botanicals to promote anti-aging and regeneration. In Panchakarma Treatment toxins are removed from the body through a detoxification process that includes Raktamokshana (bloodletting), Basti (enema), Nasya (nasal treatment), Virechana (purgation), and Vamana (emesis). Relationship Between Mind and Body In his discussion of Sattva (mind), Atma (soul), and Manas (mental health), Charaka highlighted the need of mental health for physical well-being, which is pertinent to contemporary psychosomatic medicine (Kanungo, Nagori and Kanungo, 2019; Shrestha, 2023).

5.2.3. Classification Based on Pharmacological Action

Ten medications with comparable therapeutic qualities were found in each of the 50 groups Charaka created from medicinal plants. The following are some of the main categories: Musta (Cyperus rotundus), Deepaniya (Digestive stimulants), Bala (*Sida cordifolia*), Lekhaniya (Fat-reducing), Pippali (*Piper longum),* Chitraka *(Plumbago zeylanica),* and Jivaniya (Life-promoting). Haridra (Curcuma longa), Neem (*Azadirachta indica*), and Vishaghna (anti-toxins). Guggulu (*Commiphora mukul*), Guduchi (*Tinospora cordifolia),* and Shothahara (anti-inflammatory) (Maurya Bhavna, Mishra H.S. and Agarwal Ajay Kumar, 2024)Bala has also been categorized under Balya, Brimhaniya and Prajasthapana Mahakashaya. It is used in several diseases like Vatavyadhi, Vatarakta and acts as a Rasayana. Ephedrine, pseudoephedrine, sterculic acid, malvalic acid are its main bioactive chemical constituents. It has been demonstrated to possess various pharmacological activities like CNS depressant, analgesic, anti-inflammatory, hypotensive, antidiabetic activities and the plant is reported to be used in the treatment of Parkinson's disease also. In classical texts, five varieties of Bala have been mentioned and all are said to possess similar properties and actions. All the varieties are abundantly available across the country. Thus, Bala becomes one of the most potent medicinal plants of present era. Present paper is an attempt towards exploration of therapeutic potential of the drug through reverse pharmacology.

5.2.4 Herbal Formulations

The Charaka Samhita outlines several types of herbal remedies. Fresh juice extract, or swarasa, is used for quick therapeutic results. Kalka (paste) is utilized both internally and externally. Triphala Churna (Haritaki, Bibhitaki, Amalaki) for digestion, and herbal powders for long-term usage. Kwatha (Decoction) Water-based remedies for long-term conditions. Ghrita, or medicated ghee, is used to treat neurological conditions; Brahmi ghrita is said to improve memory. Swarna Bhasma (gold ash) for immunity, and Bhasma (herbo-metallic preparations) are purified metals and minerals used in medicine (Peterson, Denniston and Chopra, 2017).

5.3. Impact on Modern Pharmacology

The Charaka Samhita's systematic taxonomy of medicinal plants and illness treatment ideas make it a significant resource for contemporary pharmacology. Numerous herbs and formulations discussed in this work have been validated by science, which has resulted in the identification of bioactive molecules like curcumin (found in turmeric), which has anti-inflammatory and anti-cancer effects. From Daruharidra, berberine antifungal and antidiabetic effects. The plant ashwagandha contains withanolides. effects that are both neuroprotective and adaptogenic.

Furthermore, the ideas of plant-derived medicines, tailored therapy (Prakriti-based treatment), and detoxification (Panchakarma) are consistent with contemporary precision medicine and drug development (Bhavana and Shreevathsa, 2014).

5.3.1 Sushruta Samhita (6th Century BCE)

One of the oldest and most thorough books on surgery and medicine is the Sushruta Samhita, which is credited to Acharya Sushruta. It is regarded as the basic literature of Shalya Tantra (Ayurvedic surgery) and was written somewhere in the sixth century BCE. The work is extremely pertinent to contemporary surgical and pharmaceutical sciences as it methodically describes surgical procedures, wound healing, medicinal herbs, and tools (A and BN, 2020).

5.4. Contributions to Surgery and Wound Healing

Sushruta is frequently referred to as the "Father of Surgery" because of his groundbreaking contributions to trauma treatment, plastic surgery, and surgical methods. The Sushruta Samhita outlines 121 surgical equipment, more than 300 surgical procedures, and methods for treating a range of illnesses.Rhinoplasty, or nose reconstruction, is one of the main contributions to surgery.

Many people consider Sushruta to be the father of plastic surgery because of his innovations in rhinoplasty, or nose repair. He explained a novel skin grafting method in the Sushruta Samhita that entailed rebuilding a broken or severed nose using a flap of skin from the forehead or face. This procedure, also referred to as the "Indian flap" technique, is among the first skin grafting and reconstructive surgery instances ever recorded. The Sushruta Samhita's description of the process (Mathes *et al.*, 2009).

Choosing the Graft Site Because it was flexible and closely resembled the nasal tissue, a piece of skin from the face or forehead was used. Skin Flap Preparation and Shaping To guarantee a blood flow throughout the grafting procedure, the skin was meticulously measured and sliced while still partially connected. Establishing the Nasal Structure To provide a smooth surface for graft adhesion, the severed nose's margins were cleaned. Placing and Fastening the Graft After rotating and positioning the skin flap over the nasal deformity, it was sewn in place using tiny stitches.Honey and medicinal plant pastes were used to aid in the healing process and guard against infection (Mathes *et al.,* 2009).

Post-Surgical Care To promote wound healing and reduce scarring, Sushruta suggested using medicinal oils, ghee-based formulations, and herbal antiseptics.This technique is still the cornerstone of contemporary cosmetic and reconstructive surgery. In Cataract Surgery he explained a primitive method of couching in which a cataract was extracted from the eye using a needle; this method was comparable to early methods in contemporary ophthalmology. Lithotomy (Bladder Stone Removal) Sushruta described how to surgically remove bladder stones, a procedure that has been improved upon in contemporary urology. Both Obstetrics and Cesarean Section (Herr, 2008; Gandhi and Patil, 2024).

5.4.1 Techniques

According to Kustha Chikitsa, fracture management involves treating bone fractures with splints, traction, and appropriate bandaging, much like modern orthopedic techniques. Abscess drainage and bloodletting (Raktamokshana) are methods of purging the blood of impurities that are now analogous to contemporary drainage and detoxification techniques. Sushruta used medicines, antiseptics, and specific bandaging procedures to promote wound healing (Vrana Ropana). In line with our current understanding of inflammation, granulation, and epithelialization in wound repair, he divided wound healing into six phases. Medicated oils and pastes for wound healing include Madhu (honey) and Haridra (turmeric), which are used as antiseptics for dressing wounds. Azadirachta indica, or neem, is known for its antibacterial properties. Commiphora mukul, or guggulu, is used for its anti-inflammatory qualities. Techniques for Suturing: explained how ant heads were used as natural surgical clips before being transformed with contemporary suturing methods. Management of Burns and Ulcers the Ghee-based formulations and cooling herbs were employed, much like contemporary topical therapies (Kilmer, 2010; Maan, Yadav and Yadav, 2017).

5.4.2. Role in Modern Pharmacognosy and Surgical Advancements

The Sushruta Samhita has extensive documentation on the pharmacological properties of medicinal herbs employed in surgical therapy. Science has proved that several of these plants are beneficial in modern treatment (Kinghorn, 2002) a long-established pharmaceutical science, has played a diverse role in the discovery, characterisation, production and standardisation of these drugs. The relevance of this discipline in terms of research and teaching has increased in the last decade as members of the public in developed countries have turned to the use of herbal remedies for the self-medication of minor diseases. However, many phytomedicines require further investigation for their clinical effectiveness, while others need to be thoroughly investigated for their potential health risks or interactions with prescription drugs. Antiseptic and anti-inflammatory herbs, such as the turmeric plant (*Curcuma longa*) Curcumin's antibacterial and anti-inflammatory qualities are supported by recent research. In line with traditional Ayurvedic treatment, vera aloe is used to promote wound healing and skin regeneration. Tinospora cordifolia, often known as guduchi, is being researched for its ability to promote immunological control and speed up the healing process after surgery. Anesthetics and Painkillers Opium-based preparations are used to relieve pain and influence modern analgesics. The sedative alkaloids included in Datura metel are now being studied in the anesthetic sector. Surgical antisepsis and infection control Modern antiseptics and wound dressings use a variety of Ayurvedic botanicals, such as neem and honey (Anand *et al.,* 2022).

5.4.3. Impact on Modern Surgery

Many of Sushruta's surgical techniques have been adopted into modern surgical practices: Sushruta's contributions to surgery, which have had a profound and long-lasting impact on modern surgical techniques, are documented in the Sushruta Samhita. Many of his innovative techniques are now accepted practices, particularly in the areas of wound healing, reconstructive surgery, and surgical equipment. Sushruta is frequently called the "father of surgery" due to his comprehensive descriptions of over 300 surgical procedures and more than 120 surgical instruments (Sheikh, 2024).

5.5. Key Contributions of Sushruta to Modern Surgery

5.5.1. Reconstructive Surgery

One of Sushruta's most well-known achievements is the reconstruction of the nose using skin grafts from the face or forehead. This technique is said to be a precursor to modern plastic surgery, namely in the area of rhinoplasty. Nowadays, flap surgery and skin grafting are often used in plastic surgery for a range of reconstructive procedures.

Tools and Procedures for Surgery

Sushruta invented many specialized instruments that are comparable to modern scalpels, forceps, and scissors. His employment of precise and sterile equipment laid the groundwork for modern surgical tool design and surgical sterilizing techniques (Sheikh, 2024).

5.5.2 Wound Healing

With his in-depth knowledge of sutures and wound care, Sushruta was ahead of his time. His approaches to treating wounds and injuries have had a direct influence on contemporary trauma care practices, where hygienic dressings and appropriate suturing techniques are critical for recovery.

Anesthesia & Pain Management: In the absence of modern anesthetics, Sushruta used plant-based drugs and herbal treatments to induce sleep and reduce pain in his patients. In contemporary anesthesiology, his early thoughts on the management of surgical pain are still being developed (V *et al.,* 2016).

5.5.3. Surgical Ethics and Patient Care

Sushruta also emphasized the importance of ethical practices and patient care in surgery by promoting hygiene, patient consent, and practitioner expertise. These concepts serve as the foundation for both modern medical ethics and patient-centered treatment(Gaikwad, More and Wele, 2015).

5.5.4. Ayurvedic Pharmacology (Dravyaguna Vigyan) and Its Scientific Basis

Dravyaguna The pharmacological properties and therapeutic benefits of medicinal substances are the focus of the Vigyan branch of Ayurveda (Dravya). It provides a detailed classification of medicinal plants, minerals, and animal products according to their taste (Rasa), qualities (Guna), potency (Virya), post-digestive influence (Vipaka), and special action (Prabhava). Modern pharmacology studies pharmacokinetics (drug mechanism of action) and pharmacodynamics (absorption, distribution, metabolism, and excretion). Ayurveda's approach to understanding how a drug interacts with the body is comparable to these disciplines of research (Patil, 2022).

5.6. Concept of Rasa, Guna, Virya, Vipaka, and Prabhava

In Ayurveda, the therapeutic effects of a medicinal plant or formulation are determined by five key factors:

5.6.1. Rasa (Taste) – Initial Interaction with the Body

The first time a medicine affects digestion and metabolism, it is called rasa. According to Ayurveda, there are six primary flavors: Madhura (sweet): strengthens, cools, and nourishes tissues (e.g., ashwagandha, licorice). Amla (sour): Helps with digestion and encourages Pitta (e.g., Amla, Tamarind). Examples of Lavana (salty) that retain water and improve taste perception are rock salt and Samudra Lavana. Katu (pungent): Lowers Kapha and speeds up metabolism (e.g., ginger, black pepper). Tikta (Bitter): Has antibacterial qualities, detoxifies the blood, and purifies it (e.g., Guduchi, Neem). Astringent Kashaya: Encourages the healing of wounds and eliminates surplus moisture (e.g., Arjuna, Haritaki). The flavor of a substance is connected to its chemical composition. Alkaloids, flavonoids, glycosides, tannins, and essential oils are thought to be responsible for the pharmacological effects seen in Ayurveda (Patil, 2022; 2024)

5.6.2. Guna (Physical and Chemical Properties)

"Guna" refers to a substance's inherent qualities that influence its medicinal effects. Ayurveda describes twenty Gunas in pairs, such as Heavy–Light (Guru–Laghu). (Snigdha–Ruksha) Dry-Oily Sharp-Dull (Tikshna–Manda) These characteristics have to do with metabolic effects, solubility, bioavailability, and biochemical activity. For instance, greasy materials enhance absorption, whereas drying processes reduce discomfort.

5.6.3. Virya (Potency – Heating or Cooling Effect)

Virya, which represents the power or energy of a material, is separated into Ushna (heat), such as ginger and black pepper, promotes digestion and increases circulation. Shita (cold) (aloe vera, sandalwood) soothes Pitta and lowers inflammation. This is in line with how heat is impacted by phytochemicals. Chili's capsaicin has a heating effect, whereas peppermint's menthol has a cooling effect (Pradesh, 2024).

5.6.4. Vipaka (Post-Digestive Effect)

Vipaka is the term used to describe a substance's long-term metabolic change that occurs after ingestion and affects its pharmacokinetics: Sweet metabolism, or Madhura Vipaka, is anabolic and nourishing (e.g., milk, ashwagandha). Amla Vipaka (sour metabolism): Promotes Pitta (lemon, vinegar) and improves digestion. Katu Vipaka (Pungent metabolism): Increases metabolism and detoxifies (e.g., Neem, Black Pepper). Vipaka is comparable to current pharmacology's biotransformation (drug metabolism). In the same way that Ayurvedic Vipaka changes things after digestion, liver enzymes change medications into active or inactive metabolites (Dhanshree K. Handibag, 2023).

5.6.5. Prabhava (Special Pharmacological Action)

The word "prabhava" refers to the unique, unexplainable effects of a drug that are not consistent with its Virya, Vipaka, Guna, or Rasa. For example, giloy's (Tinospora cordifolia) immunomodulatory qualities cannot be deduced just from its flavor or potency. Beyond general pharmacological traits, molecular mechanisms, and drug-specific receptor binding, Prabhava is linked to unique bioactivities (Sahu *et al.,* 2021).

5.6.6. Classification of Medicinal Plants Based on Therapeutic Actions

Medicinal plants are categorized by Ayurveda into functional categories based on their therapeutic qualities. The following are some of the most crucial categories:

Jivaniya (life-promoting) are Rasayana herbs (shatavari, ashwagandha) and adaptogens. Dipaniya, or digestive stimulants, include bitters and carminatives like as ajwain and ginger. Shothahara (anti-inflammatory) herbs that help to alleviate inflammation are Guggulu and guduchi. Vishugna (Antitoxic) Plants that detoxify, such turmeric and neem. Kushtaghna (therapy of skin diseases) includes herbal dermatological remedies and antimicrobials (Neem, Manjistha) (Okon, Okon and Bassey, 2024) and their use as food supplements, nutraceuticals, pharmaceutical intermediates, folk medicines, and secondary metabolites they provide for novel drugs. Therefore, an understanding of the diversity and classification of medicinal plants is useful for practitioners of ethnomedicine, botanists, and the common man for home remedies. Medicinal plants are mostly either angiosperms or gymnosperms with about 4171 and 706 plant species, respectively. Among angiospermic medicinal plants, dicotyledons have the most common representation of medicinal plants. Medicinal plants may be classified based on the following; parts used, habitat, habit, therapeutic, and ayurvedic formulations. The majority of medicinal plants are herbaceous, and about 51.3 {\\%} grow mainly in the wild. Tropical rain forest provides the highest percentage of species (54.6{\\%}.

5.7. Synergistic Effects in Polyherbal Formulations

Polyherbal formulations, which combine many herbs to boost efficacy and reduce side effects, are highly valued in Ayurveda. This is based on the concepts of Yogavahi (bioenhancer) and Samyoga (synergy).

Examples of Synergy in Ayurvedic Formulations

Triphala (Haritaki, Bibhitaki, and Amalaki) enhances digestion, immunity, and detoxification through a harmonious synergistic effect. The more than fifty herbs in chyawanprash, which possesses anti-aging, immunity-boosting, and rejuvenating qualities, include ashwagandha, guduchi, and amla. The combination of panchakola (ginger, long pepper, pippali, chitraka, and gajapippali) improves metabolism and digestion. According to contemporary phytopharmacology, polyherbal formulations enhance bioavailability, target multiple routes, and reduce drug resistance, much like combination pharmaceutical therapy. Dravyaguna Vigyan provides a systematic and scientific approach to understanding medicinal herbs. The principles of Rasa, Guna, Virya, Vipaka, and Prabhava align with concepts in modern pharmacology, such as drug metabolism, bioavailability, and receptor interactions. Ayurvedic classification, extraction methods, and polyherbal synergy have influenced modern drug discovery, phytomedicine, and tailored medicine (Mukherjee, Banerjee and Kar, 2018; Dhruvi Kasvala*, Priyanshi Monpara, 2020)the traditional medicine of India has played an important role in disease management and health for many centuries, their present frequent use is challenged by the necessity to determine their complex composition and their multitarget mode of action. Ancient Ayurvedic literature like Sarangadhar Samhita focuses on the idea of synergy or 'samyoga'. Network pharmacology research focuses on excellent systems biology techniques like protein interaction, genomic expression and mRNA expression data, which are employed to gain insight into the mechanism of action (MoA.

5.8. Conclusion

Because they include fundamental information on the therapeutic qualities of medicinal plants, minerals, and holistic treatment techniques, ancient Ayurvedic books have had a significant influence on contemporary pharmacology. By offering a multitude of bioactive substances and therapeutic methods that are still effective today, Ayurveda has made a substantial contribution to drug discovery, surgical advancements, and phytochemical study through writings like the Charaka Samhita and Sushruta Samhita. Modern pharmacological techniques are now incorporating the synergistic medication activities, polyherbal formulations, and personalized medicine concepts of Ayurveda, which promotes multidisciplinary research and evidence-based validation. The future of integrative medicine is still being shaped by Ayurveda's impact as science progresses, propelling advancements in individualized therapies, medication discovery, and preventative healthcare.

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6

Effect of Medical Astrology on Human Health

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6.1 Introduction

Medical astrology is an ancient form of astrology that has been practiced in various cultures, including Babylonian, Greek, Egyptian, and Indian traditions (Sharma *et al.*, 2007). In this system, each planet, zodiac sign, and astrological house is associated with different parts of the body, as well as various physiological and psychological states (Anigol *et al.*, 2020). While astrology itself has deep roots in divination and personality analysis, medical astrology specifically focuses on health, attempting to explain the correlation between celestial movements and bodily functions (Akasoy *et al.*, 2008).

The ancient system of Ayurveda, a traditional Indian healing science, also emphasizes balance and harmony in the body and mind (Sapna *et al.*, 2023). Ayurveda's holistic approach to health shares a conceptual overlap with medical astrology, suggesting that an individual's constitution (Prakriti) can be influenced by celestial bodies and can be assessed by astrological charts (Kandeepan *et al.*, 2019).

6.2 Historical Background

Medical astrology can be traced back to ancient civilizations, where practitioners believed the health of an individual was intimately connected to the alignment of the stars and planets (Odent, 2005). The Greeks and Romans, notably through figures such as Hippocrates and Galen, incorporated astrology into their medical practices (Sharma *et al.,* 2007). The concept gained prominence in the Middle Ages, particularly through the works of astrologers like William Lilly (Binti *et al,*.2019).

In Ayurveda, the understanding of the body and mind in relation to the cosmos and natural elements shares similarities with medical astrology. Both systems aim to restore harmony and balance to the body (Currey, 2023). Classical texts such as the "Charaka Samhita" and "Sushruta Samhita" describe the connections between natural elements and the human body, which can complement the astrological perspectives on health.

6.3 Key Concepts of Medical Astrology

- **Zodiac Signs and Body Parts:** Each zodiac sign governs a specific part of the body. For example, Aries is linked to the head, Taurus to the throat and neck, and so on (Wright,1979).
- **Planets and Their Influence:** Each planet is associated with different physiological and psychological states. For example, Mars governs energy, the liver, and aggression, while Venus relates to the kidneys, reproductive organs, and emotional well-being.
    - **Sun:** Heart, eyes, bones, fever.
    - **Moon:** Stomach, breasts, reproductive organs, emotional health.
    - **Mars:** Muscles, blood, injuries, inflammatory diseases.
    - **Mercury:** Nervous system, lungs, digestion, mental disorders.
    - **Jupiter:** Liver, gallbladder, digestive system, obesity.
    - **Venus:** Kidneys, reproductive organs, skin, metabolic issues.
    - **Saturn:** Bones, joints, skin, chronic diseases.
    - **Rahu:** Mental health, skin, addiction, cancer.
    - **Ketu:** Nervous system, abdominal issues, immune system
- **Houses and Health:** The twelve astrological houses represent various aspects of life, including health. The 1st house, for example, governs the physical body, while the 6th house is associated with diseases and health issues (Harrison,2000).

- **Aspects and Transits:** The angles between planets, or aspects, and their movements through the zodiac, known as transits, can indicate times of potential health challenges or strengths.
- **Ayurvedic Connection:** Just as Ayurveda considers the balance of doshas (Vata, Pitta, and Kapha) to determine health, medical astrology also evaluates the balance or imbalance of the planets and signs within an individual's chart to predict health outcomes (Thakur,2024).
- **Vata Imbalance:** Produces dry, irregular, and unstable states such as anxiety, constipation, arthritis, and dryness of the skin.
- **Pitta Imbalance:** Produces hot, inflamed, and intense states such as acid reflux, acne, liver ailment, and irritability.
- **Kapha Imbalance:** Produces heavy, sluggish, and congested states such as obesity, respiratory disease, and drowsiness.

6.5.1 Treatment of Dosha Imbalance

- **Vata:** To balance Vata, emphasize grounding, warming, and moisturizing therapies like warm, oily foods, routine habits, gentle exercise (such as yoga), and stress reduction.
- **Pitta:** To balance Pitta, employ cooling, soothing therapies like avoiding spicy foods, meditation, cooling herbs (such as mint), and soothing activities.
- **Kapha:** Stimulating, detoxifying therapies such as regular exercise, light diet, and exclusion of heavy or oily foods are needed to balance Kapha. Detoxifying herbs such as ginger and turmeric are useful.

By identifying the dosha imbalances and treating them with diet, lifestyle modification, and herbal interventions, Ayurveda seeks to restore equilibrium and prevent disease from occurring (Arroyo,2012).

6.4 Applications of Medical Astrology

- **Health Diagnostics and Prevention:** Medical astrology can be used to identify weak areas of health by analyzing an individual's natal chart. Astrologers might suggest preventive measures, such as lifestyle changes, dietary adjustments, or herbal treatments based on the planetary positions (Bahl *et al*,.2023).
- **Timing of Treatments:** In both astrology and Ayurveda, timing plays a crucial role in health and healing. Astrological transits can indicate auspicious times for medical treatments, surgeries, or lifestyle changes (Reiner,1985).

- **Ayurvedic and Astrological Remedies:** Combining medical astrology with Ayurvedic practices can offer holistic remedies, like adjusting diet and using herbs that correspond to the person's astrological chart. For example, a person with a strong Mars influence might benefit from cooling herbs like sandalwood or peppermint to balance the heat of Mars (Caffrey,2022).
- **Psychosomatic Conditions:** Medical astrology provides valuable insights into how mental and emotional states may manifest as physical ailments. The placement of planets like the Moon (emotions) or Mercury (mental clarity) can indicate psychological tendencies that influence physical health (Chechia, 2005).

6.5 Applications of Medical Astrology in the Contemporary Period

Medical astrology, despite being an old practice, remains applicable and useful even in the contemporary period, particularly within the context of alternative medicine and holistic health. Medical astrology in the contemporary period acts as a complementary modality to know health conditions, forecast health trends, and provide insights on individualized care (Mishra, 2024). Though it isn't embraced so extensively within general medical science, medical astrology still plays valuable roles within diverse health practice applications. A few main examples include the following:

6.5.1 Personalized Health Analysis

Medical astrology provides personalized health checks according to an individual's birth chart. Looking at the planets' positions, zodiac signs, and astrological houses at birth, practitioners can identify the inherent strengths and weaknesses of a person's physical and mental health. This personalized method helps individuals see (Abrahams *et al*,.2010).

- **Prone health issues:** Determining the parts of the body or organs that are more susceptible to imbalances or illnesses according to the zodiac signs and planets that rule them.
- **Psychosomatic Health:** Investigating the mind-body relationship, where emotional and mental states translate into physical symptoms or illnesses (e.g., stress causing digestive issues).
- **Health Timing:** Applying transits and planetary positions to identify when certain health problems may occur or when interventions and treatments are more beneficial.

6.5.2 Complementary to Ayurvedic Practices

Medical astrology is very compatible with Ayurveda as well, which focuses on balance and personalized health. Astromedicine becomes a part of the practice for most Ayurvedic practitioners to further personalize treatments according to the patient's astrological background. By assessing the doshas (Vata, Pitta, Kapha) along with the astrological chart, practitioners can (Rastogi, 2024).

- **Form Individualized Health Plans:** Diet, lifestyle, and herbal remedy addressing both the patient's constitution and astrological influences.
- **Optimal Timing for Treatments:** Using astrological timing (muhurta) to determine when a patient should begin a treatment or therapy to ensure maximum effectiveness.
- **Predictions of Health Challenges:** By understanding the planetary influences, practitioners can predict periods of vulnerability and offer preventive guidance.

6.5.3 Mental and Emotional Health

One of the most significant uses of medical astrology today is in understanding mental and emotional health. Astrology can provide insight into a person's psychological inclinations and tendencies from their natal chart (Soni *et al*,.2023).

- **Emotional Resilience:** Individuals can gain coping strategies specific to their astrological characteristics by understanding astrological influences on mood, stress reaction, and emotional control.
- **Psychological Healing:** Planets such as the Moon (emotions), Mercury (mind)and Mars (anger) impact mental well-being, and their positioning can be used to direct therapeutic interventions, including counselling or mindfulness exercises.
- **Depression and Anxiety:** Astrological charts can indicate why some people are more susceptible to conditions like depression, anxiety, or emotional instability and provide a holistic framework for managing these conditions.

6.5.4 Predictive Health Trends

Medical astrology employs the use of planetary transits in forecasting future patterns of health, allowing people the chance to pre-emptively take care of their health. The transits of major planets (e.g., Saturn, Jupiter, Mars) through someone's astrological houses may pinpoint periods of vulnerability, stress, or convalescence (Bhandari *et al*,.2018).

6.5.5 Timing Health Interventio

Astrologers may inform people on the best times for surgeries, doctor visits, or detoxification treatment according to helpful planetary transits (Harris,2005).

Seasonal and Age-Related Health: Astrological charts can be interpreted to forecast how a person's health is likely to vary with age or season. For example, there may be some seasons that have a correlation with heightened risk towards certain diseases, and individuals can take measures in advance.

6.5.6 Holistic Health and Wellness

Medical astrology aids the holistic health movement in that it fosters a wider understanding of wellness. Instead of concentrating solely on bodily symptoms, medical astrology considers the body, mind, and spirit (Ruscio, 2003).

- **Lifestyle Changes:** By knowing how the astrological chart affects an individual's habits, tastes, and inclinations (e.g., what they eat, their sleeping habits, exercise), astrology can assist one in making wiser decisions about lifestyle to ensure balance and wellness.
- **Spiritual Health:** As astrology pertains to the cosmic forces and human consciousness, it may encourage individuals to pay more attention to their life's purpose, pathway, and spiritual health, increasing overall well-being.

6.5.7 Alternative and Integrative Medicine

In the current age, various individuals want supplementary or alternative solutions in addition to traditional medicine. Medical astrology might act as an advisor to connect traditional medical intervention with holistic concepts (Drouin, 2014).

- **Herbal and Dietary Advice:** According to the astrological chart of an individual, medical astrologers can suggest herbs, foods, or supplements that correspond with the astrological constitution of the person. For instance, some planets are connected with certain foods or herbs that are assumed to balance the body.
- **Chakra and Energy Healing:** Medical astrology can be combined with energy-based healing practices like Reiki, acupuncture, and chakra healing. With the identification of energy blockages or imbalances in the body as caused by astrological factors, energy healing can be made specific to re-establish harmony.

6.5.8 Preventive Health Care

Medical astrology can provide preventive health measures according to astrological guidance. Individuals can take preventive measures against possible health problems by understanding the planetary influences on their health (Pfeffer, 2024).

- **Seasonal Adjustments:** Astrology can advise individuals on when to detoxify or follow health routines according to the planetary cycles that affect their energy.
- **Favourable Health Habits:** By understanding the astrological influences on their constitution, individuals can adapt their lifestyle to prevent common ailments associated with their dosha or planetary positions.

6.5.9 Health Education and Awareness

Medical astrology can be used as an awareness-raising tool for the need for individualized health care. With more people in the contemporary world seeking alternative medicine, astrology can enable individuals to understand their bodies and minds better (French, 1996).

- **Self-knowledge:** Individuals can understand their own bodies, health patterns, and emotional reactions better using astrology, which will promote improved self-care.
- **Empowerment:** Astrology empowers people to make informed health decisions based on their individual astrological blueprint.

6.6 Criticisms and Limitations

Despite its historical significance, medical astrology faces significant criticism, especially in the scientific and medical communities. Critics argue that there is no empirical evidence to support the connection between celestial bodies and human health. Modern medicine, based on scientific research and evidence, does not incorporate astrology in its diagnostic or treatment processes. As a result, many view medical astrology as a pseudoscience (Nutton, 2008).

Additionally, the practice of medical astrology is often dependent on interpretation, making it subjective and variable. The complex nature of astrological charts can result in different interpretations from different practitioners, further complicating its credibility.

6.7 Conclusion

Medical astrology offers a fascinating blend of ancient wisdom and holistic healing principles. While its effectiveness is debated in modern scientific circles, it remains a valuable tool for those seeking alternative and complementary health solutions. By integrating medical astrology with practices such as Ayurveda, individuals may find a unique pathway to understanding and nurturing their health, emphasizing the importance of balance, prevention, and harmony between the body and the cosmos.

Though medical astrology is not widely accepted in mainstream medical practice, its continued presence in alternative wellness circles highlights its enduring appeal. More research and evidence are needed to establish its credibility, but for many, it remains a meaningful approach to personal health and well-being. While not a replacement for modern medical treatment many, people use medical astrology as complementary tool to understand their health more deeply.it can be a way to gain emotional or psychological insides in to health problems, as well as provide guidance for preventative care or self-care. Despite its ancient routes, medical astrology is often met with skepticism within the scientific community. Many health professionals view it as a pseudo-science, as there is no empirical evidence to support the claims made by astrologers. However, for some, it can offer a unique prospective on health and well-being.

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7

The Role of Indian Knowledge in The Development of Natural Products for Pharmaceutical Use

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7.1. Introduction

Natural products have been a mainstay of drug development for centuries, providing an excellent source of bioactive molecules with therapeutic value. Natural products, ranging from plants and animals to microorganisms, have been central to the identification of medicines against a range of diseases, such as cancer, infectious diseases, and metabolic disorders (Newman and Cragg, 2020). Among the various sources of natural products, plants have played a very crucial role, and around 25% of contemporary drugs are obtained from plant constituents (Fabricant and Farnsworth, 2001). India, blessed with its vast biodiversity and long traditional knowledge base, has become a world leader in the search and utilization of natural products as medicines.

Indian traditional health systems, including Ayurveda, Siddha, and Unani, date back thousands of years and are strongly based on using medicinal plants for healing and health. These systems are recorded in ancient texts such as the Charaka Samhita, Sushruta Samhita, and

Atharva Veda, which describe medicinal plants in detail, including their properties and therapeutic uses (Patwardhan *et al.,* 2005). The integrative style of these systems, emphasizing mind, body, and spirit balance, has drawn international interest and has been adopted more and more into contemporary health care.

Indian knowledge has significantly contributed to the evolution of natural products as drugs. For example, the isolation of vinca alkaloids from *Catharanthus roseus* (Madagascar periwinkle) transformed cancer treatment, and compounds such as vinblastine and vincristine are now key ingredients in chemotherapy protocols (Noble, 1990). Equally, curcumin, the bioactive molecule in turmeric (*Curcuma longa*), has been well-researched for its anti-inflammatory, antioxidant, and anticancer activities, which has seen it find its way into numerous nutraceuticals and pharmaceuticals (Aggarwal *et al.,* 2007). These instances highlight the promise of Indian medicinal plants and traditional knowledge in meeting global health needs.

Despite the increased focus on natural products, there is still a wide gap in the convergence of traditional knowledge with conventional scientific investigation. While traditional medicine systems have vast data regarding medicinal plants and their applications, the absence of systematic validation and standardization has slowed their general acceptance in the international pharmaceutical industry (Patwardhan *et al.,* 2005). Nonetheless, recent advances in ethnopharmacology, phytochemistry, and biotechnology have opened new avenues to close this gap, allowing for the scientific proof of traditional medicines and the discovery of new drugs.

7.2. Historical Context of Indian Traditional Knowledge

The history of traditional Indian medicine runs deep in the cultural, spiritual, and scientific traditions of the Indian subcontinent, going back thousands of years. Indian traditional knowledge systems, such as Ayurveda, Siddha, and Unani, have been developed over millennia, providing a holistic perspective to health and wellness that focuses on mind, body, and spirit harmony. These systems reflect not just India's rich cultural heritage but also a storehouse of valuable information regarding medicinal plants and their medicinal uses.

7.2.1. Origins and Evolution of Ayurveda

Ayurveda, also known as the "science of life," is among the world's oldest systems of medicine, whose origins go back to the Vedic era (around 1500–500 BCE). The original texts of Ayurveda, the Charaka Samhita and the Sushruta Samhita, were written around 600 BCE and

300 BCE, respectively, and are still landmark works in the history of traditional medicine (Mukherjee *et al.*, 2022). The Charaka Samhita is concerned with internal medicine and the principles of diagnosis and treatment, whereas the Sushruta Samhita is famous for its elaborate descriptions of surgical procedures and instruments.

Ayurveda operates on the principle of three doshas - Vata, Pitta, and Kapha - which are the basic physiological mechanisms that regulate the human body. Health is viewed as a condition of balance between these doshas, whereas disease is caused by the imbalance of doshas. Ayurvedic therapies seek to balance this by the use of herbal medicines, dietary intake, lifestyle, and detoxing therapies (Patwardhan *et al.*, 2005). Medicinal plant usage, including Tulsi (*Ocimum sanctum*), Ashwagandha (*Withania somnifera*), and Haritaki (*Terminalia chebula*), forms the core of Ayurvedic practice, with more than 600 plant species recorded in Ayurvedic literature for their medicinal uses (Mukherjee *et al.*, 2022).

7.2.2. Siddha Medicine: The Southern Tradition

Siddha medicine, developed in the Tamil-speaking areas of South India, is another old system of medicine that is similar to Ayurveda but also has its own principles and practices. "Siddha" means the realization of perfection, and the system is credited to the Siddhars, spiritual sages believed to have been endowed with advanced knowledge of medicine, alchemy, and spirituality.

The Siddha system is founded on the theory of the five elements (earth, water, fire, air, and ether) and the three humors (Vatham, Pitham, and Kapham), which are similar to the Ayurvedic doshas. Siddha medicine focuses on the employment of metals, minerals, and herbs in its preparations, with a special emphasis on rasayana (rejuvenation) therapies for the enhancement of longevity and vigor (Iqbal, 2022). Prominent medicinal plants of Siddha medicine are Karisalai (*Eclipta prostrata*) for liver disease and Nilavembu (*Andrographis paniculata*) for fever and inflammation.

7.2.3. Unani Medicine: The Greco-Arabic Influence

Unani medicine, which comes from the Greek term "Ionian," was brought to India by Arab and Persian physicians during the medieval era. It is founded on the principles of Hippocrates and Galen and was enhanced by Islamic physicians like Avicenna (Ibn Sina) and Rhazes (Al-Razi) (Parveen *et al.*, 2022). Unani medicine was adopted by India's Mughal rulers, who set up hospitals and schools to foster its practice.

The Unani system is based on the four-humor theory (blood, phlegm, yellow bile, and black bile) and the four elements (earth, water, fire, and air). Health is considered a state of equilibrium between these humors, and treatment consists of the administration of natural products, such as herbs, minerals, and animal substances, to reestablish this equilibrium (Parveen *et al.*, 2022). Some of the most common medicinally used plants in Unani medicine are Zafran (*Crocus sativus*) for depression and Asgandh (*Withania somnifera*) for stress and exhaustion.

7.2.4. Folk Medicine and Tribal Knowledge

Aside from these formal systems, India boasts a rich legacy of folk medicine practiced by indigenous peoples and tribal communities. This information, handed down over the generations by word of mouth, is based closely in the immediate environment and exhibits a rich awareness of the therapeutic properties of plants, animals, and minerals (Sood *et al.*, 2018). For instance, the western Indian Bhil tribe employs Karanja (*Pongamia pinnata*) for dermal diseases, while the Santhal tribe in eastern India employs Sarpagandha (*Rauvolfia serpentina*) to treat hypertension (Pathy *et al.*, 2021). These traditional methods, although less written down, have also made important additions to the treasure house of Indian medical knowledge.

7.2.5. Documentation and Conservation

The conservation of Indian traditional knowledge has been aided by ancient literature, oral tradition, and, more recently, electronic databases like the Traditional Knowledge Digital Library (TKDL). Government of India collaborated with Council of Scientific and Industrial Research (CSIR) so that TKDL seeks to record and safeguard India's traditional knowledge against biopiracy and intellectual property violations (Fredriksson, 2022). The program has not only preserved India's medicinal legacy but also contributed a rich treasure for contemporary drug discovery.

7.3. Key Contributions of Indian Medicinal Plants to Pharmaceuticals

Indian medicinal plants played a key role in the development of modern drugs, yielding a rich store of bioactive compounds with wide-ranging therapeutic activity. These plants, embedded within traditional systems of knowledge like Ayurveda, Siddha, and Unani, have been widely investigated for their utility against metabolic disorders and infectious diseases including cancer.

7.3.1. Turmeric (*Curcuma longa*): Curcumin and its Multifaceted Applications

Turmeric, a yellow-colored spice obtained from the rhizomes of *Curcuma longa*, has been a mainstay of Indian traditional medicine for centuries. Its active constituent, curcumin, has attracted worldwide attention due to its anti-inflammatory, antioxidant, and anticancer activities (Kaur *et al.*, 2024).

- **Anticancer Activity:** Curcumin has the ability to influence several signaling pathways that play a role in cancer growth, including NF-κB, PI3K/Akt, and MAPK pathways. It triggers apoptosis and prevents angiogenesis and metastasis in different cancer cell lines (Aggarwal *et al.*, 2007).
- **Clinical Applications:** Curcumin formulations are under investigation in clinical trials for their ability to treat breast, colon, and prostate cancers. Curcumin nanoformulations have been created to increase its bioavailability and therapeutic effectiveness (Nasery *et al.*, 2022).
- **Anti-inflammatory and Antioxidant Activity:** Curcumin's free radical scavenging and anti-oxidant properties have rendered it a potential drug candidate for treating chronic inflammatory disorders like arthritis and neurodegenerative diseases (He *et al.*, 2015).

7.3.2. Neem (*Azadirachta indica*): A Multifaceted Therapeutic Agent

Neem, also known as the "village pharmacy," is among the most useful medicinal plants in India. Its bioactive compounds like azadirachtin, nimbin, and nimbidin display a vast array of pharmacological activities (Prakash *et al.*, 2022).

- **Antimicrobial Activity:** Neem extracts have exhibited strong antibacterial, antiviral, and antifungal activities. For example, azadirachtin has been found to suppress the replication of herpes simplex virus and human immunodeficiency virus (HIV) (Wylie and Merrell, 2022).
- **Anticancer Activity:** Neem compounds induce apoptosis in cancer cells by activating caspase pathways and suppressing cell proliferation. They have exhibited potential in preclinical models against breast, lung, and pancreatic cancers (Nagini *et al.*, 2024).
- **Dermatological Uses:** Neem is extensively applied in skin care products due to its anti-acne, anti-aging, and wound-healing

activities. Its antioxidant and anti-inflammatory properties make it effective in managing skin conditions such as eczema and psoriasis (Srivastav *et al.,* 2024).

7.3.3. Ashwagandha (*Withania somnifera*): Adaptogen and Beyond

Ashwagandha, also known as Indian ginseng, is a key herb in Ayurveda known for its immunomodulatory and adaptogenic properties. The bioactive moieties such as withanolides, withaferin A, and sitoindosides from Ashwagandha have been widely researched for their therapeutic benefits (Mounica *et al.,* 2022).

- **Anticancer Activity:** Withaferin A inhibits tumor growth by inducing apoptosis as well as angiogenesis inhibition. It also potentiates the action of standard chemotherapy drugs (Kumar *et al.,* 2023).
- **Neuroprotective Effects:** Ashwagandha has exhibited neuroprotective activity in preclinical models of Alzheimer's and Parkinson's diseases. It lowers oxidative stress and inflammation in the brain, enhancing cognitive function (Zahiruddin *et al.,* 2020).
- **Stress and Anxiety Relief:** Clinical trials established that Ashwagandha supplementation lowered cortisol levels and improved signs and symptoms of stress and anxiety, and hence is a most sought-after adaptogen in contemporary herbal medicine (Kaul and Wadhwa, 2024).

7.3.4. Vinca Alkaloids: *Catharanthus roseus* to Cancer Treatment

Vinca alkaloids, the cancer-treating drugs obtained from *Catharanthus roseus* of India origin or Madagascar periwinkle, are changing cancer therapy (Paul *et al.,* 2023).

- **Mode of Action:** Vinca alkaloids prevent the formation of microtubules in the division process of a cell, inducing cancer cell cycle arrest and apoptosis. They especially show activity in treating hematologic cancers like lymphoma and leukemia (Dhyani *et al.,* 2022).
- **Clinical Uses:** Vincristine and vinblastine are administered extensively in chemotherapy protocols for their strong antitumor activity. Synthetic analogues have been aimed at developing newer agents with improved efficacy and diminished toxicity (Škubník *et al.,* 2021).

7.3.5. Tulsi (*Ocimum sanctum*): The Holy Basil

Tulsi, or holy basil, is sacred in Indian culture due to its medicinal and spiritual values. Its bioactive constituents, including eugenol, ursolic acid, and rosmarinic acid, possess a broad spectrum of pharmacological activities (Thakur and Thapa, 2023).

- **Antioxidant and Anti-inflammatory Effects:** Tulsi extracts have been found to decrease oxidative stress and inflammation, rendering them useful in the treatment of chronic diseases like diabetes and cardiovascular disorders (Fatima, 2022).
- **Antimicrobial Activity:** Tulsi possesses broad-spectrum antimicrobial activity against fungi, viruses, and bacteria. It has been traditionally used in medicine to treat skin diseases and respiratory infections (Kodgire *et al.,* 2023).
- **Adaptogenic and Antistress Activity:** Tulsi contains adaptogenic effects, which aid the body to adapt to physical and emotional stress. Clinical trials have demonstrated that supplementation with Tulsi enhances stress resistance and well-being (Winston, 2019).

7.3.6. Reserpine: From *Rauwolfia serpentina* to the Treatment of Hypertension

Rauwolfia serpentina, or sarpagandha, is the origin of reserpine, an alkaloid utilized in treating hypertension and mental illnesses (Bunkar, 2017).

- **Mechanism of Action:** Reserpine blocks the reuptake of norepinephrine from nerve terminals, resulting in lowered blood pressure and sedation. It was the first antihypertensive drug that was developed from a natural product (Bunkar, 2017).
- **Clinical Applications:** While its application has decreased as a result of side effects, reserpine is a significant medication in the pharmacologic past and remains investigated for its utility in psychiatric disorder management (Bunkar, 2017).

7.3.7. Guggul (*Commiphora wightii*): Lipid-Lowering Agent

Guggul, which is obtained from the resin of *Commiphora wightii*, has been utilized in Ayurveda due to its lipid-lowering and anti-inflammatory effects. Its active ingredients, guggulsterones, have been researched for its potential in controlling hyperlipidemia and obesity (Azharhusain *et al.,* 2022).

- **Mechanism of Action:** Guggulsterones influence lipid metabolism by inducing the farnesoid X receptor (FXR) and suppressing cholesterol production. They are also anti-inflammatory and antioxidant agents (Azharhusain *et al.,* 2022).

- **Clinical Applications:** Guggul-based formulations are used in modern medicine to manage hyperlipidemia and prevent cardiovascular diseases (Ahmad *et al.,* 2020).

7.4. Integration of Indian Knowledge with Modern Drug Discovery

The combination of Indian traditional knowledge with contemporary drug discovery has created new opportunities for the creation of new therapeutics. Indian traditional medicine systems like Ayurveda, Siddha, and Unani have vast information on medicinal plants and their therapeutic uses. Yet, due to the absence of systematic validation and standardization, they have been restricted from gaining global acceptance in the past. The latest research in ethnopharmacology, phytochemistry, and biotechnology has closed the gap, facilitating scientific proof of traditional medications and the creation of evidence-based medicines. This part discusses the method, issues, and possibilities of combining Indian knowledge with contemporary drug development.

7.4.1. Ethnopharmacology: Connecting Traditional Knowledge and Modern Science

Ethnopharmacology, or the discipline of studying indigenous medicinal practices, is important to the identification of potential drug lead molecules from Indian medicinal plants. Documenting indigenous plant uses and their efficacy based on scientific parameters makes it possible to discover novel bioactive agents of therapeutic importance (Pirintsos *et al.,* 2022).

Case Study:

- **Curcumin from Turmeric:** Turmeric (*Curcuma longa*) was used traditionally in Ayurveda to heal wounds and reduce inflammation, which identified curcumin, a highly active anti-inflammatory and anticancer substance. Recent science has confirmed its mechanisms of action and assessed its utility in clinical practice (Nasery *et al.,* 2022).
- **Vinca alkaloids of** *Catharanthus roseus***:** Vinca alkaloids are use in traditional medicine for diabetes treatment resulted in the isolation of these alkaloids, which have been extensively applied in cancer chemotherapy (Noble, 1990).

7.4.2. Phytochemical Screening and Isolation of Bioactive Compounds

Current phytochemical methods have facilitated the isolation and characterization of bioactive compounds from Indian medicinal plants. These compounds are the basis of drug development.

Methods Applied

- **High-Performance Liquid Chromatography (HPLC):** For separation and quantification of bioactive molecules.
- **Gas Chromatography-Mass Spectrometry (GC-MS):** For volatile compound identification.
- **Nuclear Magnetic Resonance Spectroscopy (NMR):** For structural elucidation of intricate molecules.

7.4.3. Preclinical and Clinical Validation

The combination of traditional knowledge and contemporary drug discovery includes strict preclinical and clinical validation to ascertain the safety and efficacy of drug candidate molecules.

Preclinical Studies:

- *In Vitro* **Studies:** Bioactivity-guided screening of bioactive compounds for cytotoxicity, antioxidant activity, and mode of action using cell lines.
- *In Vivo* **Studies:** Therapeutic efficacy and toxicity assessment in animal models (Khan *et al.,* 2019).

Clinical Trials:

- **Phase I:** Dosage and safety assessment in healthy volunteers.
- **Phase II:** Efficacy and side effect evaluation in patients.
- **Phase III:** To track adverse drug reactions and to establish efficacy (Thall, 2008).

Examples:

- **Curcumin:** Some Clinical trials have investigated curcumin's therapeutic potential for neurodegenerative disorders, inflammatory diseases, and cancers (Gupta *et al.,* 2013).
- **Ashwagandha:** It was clinically proven that Ashwagandha was effective in controlling anxiety, stress, and inflammation.

7.5. Challenges and Opportunities

Combining Indian traditional knowledge with modern drug discovery holds immense promise for developing new therapies. However, this integration comes with its own set of challenges. Addressing these hurdles and leveraging the opportunities can pave the way for global recognition and adoption of Indian traditional medicine in healthcare systems worldwide.

7.5.1. Challenges in Integrating Indian Traditional Knowledge

Lack of Standardization

One of the main issues in combining Indian traditional knowledge and contemporary drug discovery is the absence of standardization in the preparation and application of herbal medicines. Variation in the quality and constitution of herbal preparations based on differences in cultivation, harvesting, and processing methods can cause unpredictable therapeutic effects (Sen and Chakraborty, 2017).

- **Example:** Bioactive compound concentrations in Ashwagandha (*Withania somnifera*) may widely vary according to geographical position, soil type, and harvesting practices (Kumar *et al.,* 2023).
- **Solution:** Standardized cultivation methods, harvesting procedures, and processing steps for medicinal plants can make herbal preparations consistent in quality and activity.

Intellectual Property Rights

Protection of traditional knowledge against biopiracy and exploitation is a major issue. Foreign groups have patented most traditional medicines without due recognition and benefit-sharing with the indigenous population (Pathak *et al.,* 2024).

- **Example:** Foreign corporations' patenting of Neem (*Azadirachta indica*) and Turmeric (*Curcuma longa*) has been a subject of controversy over intellectual property rights and ethical usage of traditional knowledge (Malik and Zafar, 2005)
- **Solution:** Programs such as the Traditional Knowledge Digital Library (TKDL) are designed to document and safeguard India's traditional knowledge against biopiracy. Legal frameworks can be further enhanced and benefit-sharing agreements encouraged to further protect traditional knowledge.

Regulatory Barriers

Tight regulatory standards for the approval of herbal drugs in most nations are a major challenge. Inadequate strong scientific evidence to prove the efficacy and safety of traditional medicines may hamper their uptake in the international market (Zhang, 2010).

- **Example:** The United States and European Union have a process of regulatory approval for herbal medicines that involves significant preclinical and clinical data, which may be expensive and time-consuming (Hossain *et al.*, 2022).
- **Solution:** Standardized guidelines for the assessment and approval of herbal medicines can help make them a part of modern healthcare systems.

Limited Scientific Validation

Most traditional medicines do not have strong scientific evidence to prove their effectiveness and safety. Lack of well-conducted clinical trials and mechanistic research can restrict the acceptance of traditional medicines by the scientific community (Zhang and Organization, 2000).

- **Example:** Although, Tulsi (*Ocimum sanctum*) has been used traditionally for its antimicrobial and anti-inflammatory activities. Additional clinical studies are required to establish its therapeutic value.
- **Solution:** Implementing intense preclinical and clinical trials to establish the efficacy and safety of traditional remedies can make them more credible and acceptable.

7.5.2. Opportunities in Integrating Indian Traditional Knowledge

Collaborative Research

Collaborative work among traditional healers, scientists, and drug companies can hasten the identification and development of new therapeutics. Through synergistic integration of traditional medicine's wisdom with advanced scientific methods, researchers can release the therapeutic value of Indian medicinal plants (Puri, 2007).

- **Example:** Collaborative research on Curcumin of Turmeric has resulted in the formulation of nano formulations to improve its bioavailability and therapeutic action (Yallapu *et al.*, 2015).
- **Opportunity:** Forming research consortia and collaborations has the potential to promote the sharing of knowledge and resources, ultimately resulting in the creation of evidence-based therapies.

Application of Advanced Technologies:

Nanotechnology and omics have the potential to improve the discovery and development of drugs from Indian medicinal plants.

- **Nanotechnology:** Nano formulations of bioactive compounds may enhance their solubility, stability, and bioavailability, thus improving their therapeutic efficacy.

- **Example:** Nano-curcumin formulations have demonstrated enhanced anticancer activity in preclinical models (Yallapu *et al.,* 2015).
- **Omics Technologies:** Genomics, proteomics, and metabolomics can give insights into the molecular mechanisms of action of traditional remedies and identify new drug targets.
- **Example:** Transcriptomic analysis of Ashwagandha has identified key genes involved in its anti-inflammatory and neuroprotective effects.

Development of Nutraceuticals and Functional Foods

Indian medicinal plants are utilized to create nutraceuticals and functional foods for the prevention and management of diseases. Increased demand for herbal medicines and natural products is a huge opportunity for the international spread of Indian traditional medicine (Gunjan *et al.,* 2015).

- **Example:** Ashwagandha-based nutraceuticals are extensively used for stress relief and immune support.
- **Opportunity:** Formulating standardized formulations with clinical trials can improve the credibility of essential food commodities and nutraceuticals with market value.

7.5.3. Global Market Potential:

The international market for traditional herbal medicines and natural products is expanding fast, fueled by rising consumer demand for effective and safe replacements for man-made drugs. Indian traditional medicine has a long history and established effectiveness and is well-placed to take advantage of the trend.

- **Example:** The world market of Curcumin and its related products is estimated to grow to $1.3 billion by 2025, fueled by its extensive spectrum of therapeutic uses (Beganovic and Wittmann, 2024).
- **Opportunity:** By strategically promoting Indian traditional medicine on a global scale through focused marketing efforts, building strong partnerships, and improving regulatory standards, its market potential can be greatly amplified.

7.6. Conclusion

The combination of Indian traditional knowledge and contemporary drug discovery is a potential new front in the discovery of new therapeutics. Indian traditional medicine systems, including Ayurveda, Siddha, and

Unani, provide a treasure trove of information on medicinal plants and their clinical uses. These systems, based on centuries of experience and observation, have been the source of inspiration for the identification of many bioactive compounds with important pharmaceutical value. From withanolides and guggulsterone to vinca alkaloids and curcumin, Indian medicinal plants have made a significant contribution to the world's pharmaceutical industry, especially with respect to cancer, infectious diseases, and metabolic disorders.

The historical background of Indian traditional knowledge puts into perspective its profound linkage with the Indian subcontinent's scientific and cultural heritage. Ancient writings such as the Charaka Samhita and Sushruta Samhita detail the application of medicinal plants for the purpose of healing and health, and modern scientific studies have scientifically confirmed many of these ancient treatments. The role played by Indian medicinal plants in present-day pharmaceuticals, including the synthesis of anticancer drugs from *Catharanthus roseus* and anti-inflammatory compounds from *Curcuma longa*, is testimony to the usefulness of combining traditional wisdom with modern drug discovery.

But this incorporation is not an easy one. The absence of standardization, intellectual property, regulatory barriers, and limited scientific testing have obstructed the global adoption of Indian traditional medicine. To overcome these challenges, cooperative work among traditional practitioners, scientists, and policy-makers is called for. Efforts such as the Traditional Knowledge Digital Library (TKDL) have been responsible for documenting and safeguarding India's medicinal legacy, while innovations in ethnopharmacology, phytochemistry, and biotechnology have allowed for the scientific authentication of folk remedies.

The scope for blending Indian traditional knowledge with contemporary drug discovery is immense. Joint research, the application of sophisticated technologies like nanotechnology and omics, and the creation of nutraceuticals and functional foods provide new ways for the discovery and development of evidence-based medicine. Globalization of Indian traditional medicine will increase global demand for natural products and herbal medicines.

In summary, the combination of Indian traditional medicine and contemporary drug discovery has the ability to reshape the pharmaceutical business. Through uniting the teachings of ancient drug systems with advances in scientific approaches, scientists will be able to release the health benefits of Indian medicinal plants to the world while supporting global wellbeing. However, ensuring that the complications of standardization, intellectual property rights, legal requirements, and scientific verification exist is critical if this potential must be realized in full. Joint initiatives, backed by sound research and policy structures, have the potential to open the gates for the universal acceptance and adoption of Indian traditional medicine in contemporary healthcare.

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8

Yogasan: An Ancient Therapy for Treatment of Various Illness

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8.1 Introduction

Yoga, a discipline that has been practiced for thousands of years, has its roots deeply embedded in Indian philosophy and spirituality. The word "yoga" is derived from the Sanskrit root *yuj*, meaning "to unite or integrate," signifying the union of the individual consciousness with universal consciousness (Iyengar, 1966). Over time, yoga has transcended its spiritual and religious contexts to become a popular form of exercise and mental health practice across the globe. With the increasing focus on holistic health in the contemporary world, yoga has garnered significant attention for its potential to improve physical, mental, and emotional well-being. Yoga involves a combination of postures (asanas)., breath control (pranayama), meditation, and ethical principles, which aim to achieve harmony between the body and mind (Feuerstein, 1998). Modern practice often focuses more on the physical postures, but it is important to recognize that yoga is a comprehensive system that integrates the body, mind, and spirit. As the practice becomes more widespread, both scientific and anecdotal evidence continues to support the positive effects of yoga on physical fitness, stress reduction, and overall health.

This paper will review the key concepts of yoga, its history, various styles, its health benefits, and its impact on mental well-being. It will also discuss the scientific research on yoga's effects and explore potential avenues for future research.

8.2 Historical Background of Yoga

Yoga has a long and complex history, dating back over 5,000 years. Its earliest references can be found in the ancient texts of the Vedas, the oldest sacred scriptures of Hinduism. The practice of yoga evolved over time, influenced by various Indian philosophical schools, including Vedanta, Sankhya, and Buddhism. One of the most important texts in the yoga tradition is the *Yoga Sutras* by Patanjali, written around 200 bce. In this text, Patanjali outlined the eight-limbed path (Ashtanga Yoga), a system of practices designed to bring about physical, mental, and spiritual discipline.

The early forms of yoga were primarily concerned with meditation and ascetic practices. The physical postures (asanas) used in modern yoga were introduced later as part of the Hatha Yoga tradition, which was designed to prepare the body for long periods of meditation (Feuerstein, 1998). Hatha Yoga emphasizes physical postures, breath control, and purification techniques to cultivate a strong and flexible body, as well as a calm and focused mind. The modern understanding of yoga as primarily a physical exercise evolved in the late 19th and early 20th centuries, especially as yoga teachers such as Swami Vivekananda and Krishnamacharya began to spread the practice to the West. Krishnamacharya's teachings, particularly his emphasis on the physical postures, laid the foundation for many of the modern styles of yoga practiced today (Mallinson, 2017).

8.3 Different Types of Yoga

Over time, many different schools of yoga have emerged, each with unique practices and focuses. While the traditional eight-limbed path of Patanjali's *Yoga Sutras* remains foundational, many modern styles of yoga prioritize different aspects of the practice, **(Fig.1)** from physical postures to breathing techniques and meditation.

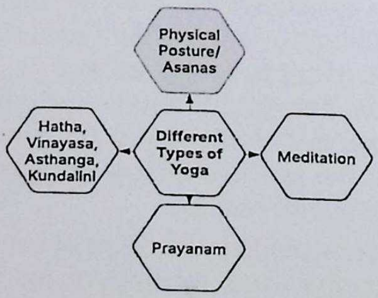

Fig. 1: Different types of Yoga

8.3.1 Physical Postures, or Asanas

Asanas are physical positions intended to enhance general health, strength, flexibility, and balance. Numerous illnesses have been shown to be relieved and even cured by regular asana practice:

- **Chronic Pain:** Yoga positions can help those with chronic back pain and arthritis by reducing muscular tension and increasing joint mobility (Govindaraj R *et al.,* 2016).
- **Heart Health:** Asanas that increase circulation, decrease blood pressure, and support cardiovascular health include backbends, twists, and inversions.
- **Digestive Problems:** Forward bends and twists, which gently compress and stretch the belly, can help improve digestion by stimulating the digestive organs
- **Respiratory Disorders:** By expanding the chest and enhancing circulation, asanas can help reduce the symptoms of asthma and other respiratory disorders while also increasing lung capacity (Desveaux, *et al.,* 2015).

8.3.2 The Practice of Meditation

The treatment of stress-related illnesses greatly benefits from meditation's ability to quiet the mind and focus attention on the here and now. Meditation works well for:

- **Reducing Stress And Anxiety:** By lowering the body's levels of the stress hormone cortisol and anxiety, regular meditation can help manage disorders including depression and high blood pressure.
- **Immunity-Boosting:** Studies have demonstrated that meditation strengthens the immune system by lowering stress and encouraging calm.
- **Pain Management:** Research has shown that mindfulness and meditation can change how people perceive pain, enabling them to manage chronic pain without the need for prescription drugs.
- **Mental Health:** By promoting mental clarity, decreasing negative thinking patterns, and boosting emotional resilience, regular practice can be especially helpful in lowering symptoms of depression, PTSD, and other mood disorders (Bridges, L., & Sharma, M. 2017).

8.3.3 Breathing Exercises, or Pranayama

Controlled breathing techniques (**Table 1**) known as pranayama aid in regulating the body's prana, or life energy. Pranayama practice has been connected to:

- **Health of the Respiratory System:** Pranayama enhances oxygen intake, improves lung function, and fosters greater respiratory efficiency. It works very well for bronchitis, asthma, and other respiratory ailments.
- **Stress Relief:** By calming the nervous system, deep breathing balances stress hormones and lessens the body's fight-or-flight reaction (Ross A & Thomas S 2010).
- **Better Circulation:** By improving blood flow and assisting in blood pressure regulation, controlled breathing lowers the risk of heart disease and stroke.
- **Detoxification:** Pranayama promotes the body's removal of toxins and boosts metabolic efficiency through techniques like Kapalbhati and Bhastrika (RN,BS N.2014).

8.3.3.1 Hatha Yoga

Hatha Yoga is one of the most popular and foundational forms of yoga. The term "Hatha" means force, and it refers to the discipline of physical postures and breath control designed to purify the body and prepare it for meditation (Iyengar, 1966). Hatha Yoga classes typically involve slower-paced sessions with a focus on alignment, balance, and flexibility. It is often considered an introductory practice for beginners as it emphasizes the fundamentals of posture and breathing.

8.3.3.2 Vinyasa Yoga

Vinyasa Yoga is characterized by flowing, dynamic movements that are synchronized with the breath. Unlike Hatha Yoga, which is typically slower and more deliberate, Vinyasa Yoga involves a series of postures that flow together in a sequence. Vinyasa is often referred to as "flow yoga" due to the seamless transitions between poses. This style of yoga is popular for its cardiovascular benefits, as it involves continuous movement and often incorporates sun salutations, which are vigorous sequences designed to warm up the body (Prichard, 2015).

8.3.3.3 Ashtanga Yoga

Ashtanga Yoga is a more structured and demanding form of yoga that follows a set sequence of postures performed in a particular order. Each posture is held for a specific number of breaths, and the practice emphasizes the importance of a steady, rhythmic breath (Ujjayi pranayama). Ashtanga practitioners typically perform the same series of postures in every class, making the practice highly disciplined and physically challenging (David, 2016). Ashtanga Yoga is known for its ability to build strength, flexibility, and stamina.

8.3.3.4 Kundalini Yoga

Kundalini Yoga focuses on the awakening of the dormant energy (Kundalini) at the base of the spine and its ascent through the chakras to achieve spiritual enlightenment. This practice combines dynamic movements, breathing exercises, chanting, and meditation. The goal of Kundalini Yoga is to release emotional blockages, increase vitality, and promote spiritual awareness (Khalsa, 2004). Kundalini Yoga is often seen as one of the more spiritually intense forms of yoga.

8.3.3.5 Bikram Yoga

Bikram Yoga, developed by Bikram Choudhury in the 1970s, consists of a fixed series of 26 postures and two breathing exercises practiced in a room heated to approximately 105°F (40°C). The heat is intended to promote flexibility and help detoxify the body by inducing sweating. Bikram Yoga has gained popularity for its intense physical challenge and the purported benefits of heat in increasing the effectiveness of the postures (Garcia, 2013).

Table 1: Different types of yoga treatment for treatment of various illness

Disease /Condition	**Yoga Treatment**			**Benefits**
	Asanas	**Pranayama**	**Meditation**	
Arthritis	Child's Pose (Balasana), Adho Mukha Svanasana (Downward Dog), and Pashimottanasana (Seated Forward Fold)	Alternate Nostril Breath, Kapalbhati, Nadi Shodhana	Yoga Nidra	Enhances mobility and flexibility by lowering inflammation and joint stiffness. Reduces stress and discomfort; improves joint circulation
Back Pain	Cat-Cow Pose (Marjaryasana-Bitilasana), Bridge Pose (Setu Bandhasana), Cobra Pose (Bhujangasana)	Nadi Shodhana, Ujjayi (Victorious Breath)	Transcendental Meditation(Deep Breath)	Back muscles are strengthened and stretched, tension and soreness are reduced. Spinal alignment are enhanced, general flexibility and muscular support are encouraged.

Disease /Condition	**Yoga Treatment**			**Benefits**
	Asanas	**Pranayama**	**Meditation**	
Asthma	Bridge Pose (Setu Bandhasana), Cobra Pose (Bhujangasana), Warrior Pose (Virabhadrasana)	Anulom Vilom (Alternate Nostril Breathing), Ujjayi	Transcendental Meditation(Deep Breath)	Enhances oxygen intake and flow. Reduce stress and anxiety triggers, improves respiratory function and expands lung capacity.
Hypertension (High Blood Pressure)	Legs-Up-the-Wall (Viparita Karani), Child's Pose (Balasana), Corpse Pose (Savasana)	Nadi Shodhana, Bhramari (Bee Breath)	Loving-Kindness Meditation (Compassion and Empathy)	Lowers blood pressure, soothes the nervous system, eases tension and anxiety. Enhances circulation, and encourages relaxation.
Diabetes	Warrior Pose (Virabhadrasana), Boat Pose (Navasana), Bow Pose (Dhanurasana)	Kapalbhati, Bhastrika (Bellows Breath)	Yoga Nidra	Controls blood sugar levels, boosts insulin sensitivity, enhances circulation, aids in digestion and metabolism.
Depression & Anxiety	Standing Forward Bend (Uttanasana), Seated Forward Fold (Paschimottanasana), Child's Pose (Balasana)	Bhramari, Nadi Shodhana, Ujjayi Meditation: Mindfulness, Yoga Nidra	Guided Meditation (By Teacher or Others focus on our goal)	Lessens despair and anxiety. Enhances emotional equilibrium and mental clarity; eases mental strain; encourages deep concentration and relaxation.
Insomnia	Reclining Bound Angle Pose (Supta Baddha Konasana), Child's Pose (Balasana), Legs-Up-the-Wall (Viparita Karani)	Nadi Shodhana, Bhramari	Yoga Nidra, Mindfulness Meditation	Enhances the quality of sleep, eases tension and stress, encourages deep relaxation; soothes the neurological system and creates a state of rest.

Disease /Condition	Yoga Treatment			Benefits
	Asanas	Pranayama	Meditation	
Chronic Fatigue Syndrome (CFS)	Cat-Cow Pose (Marjaryasana-Bitilasana), Child's Pose (Balasana), Cobra Pose (Bhujangasana)	Ujjayi, Kapalbhati	Yoga Nidra	Increases energy levels Reduces fatigue and mental exhaustion Improves muscle strength and flexibility Enhances mental clarity and emotional balance
Digestive Disorders (IBS, Constipation)	Wind-Relieving Pose (Pavanmuktasana), Cobra Pose (Bhujangasana), Seated Twist (Ardha Matsyendrasana)	Kapalbhati, Ujjayi, Nadi Shodhana	Dhyana	Reduces bloating and improves digestion, stimulates the stomach organs, eases constipation and increases blood flow to the digestive organs.
Cancer (Supportive Treatment)	Child's Pose (Balasana), Savasana (Corpse Pose), Warrior Pose (Virabhadrasana)	Nadi Shodhana, Ujjayi	Yoga Nidra, Mindfulness	Lowers stress and anxiety, encourages emotional recovery, boosts vitality, and enhances general wellbeing both during and after treatment.

8.4 Health Benefits of Yoga

The practice of yoga has been shown to have a wide range of health benefits, both physical and psychological. Several studies have explored the physiological effects of yoga, with many reporting positive outcomes in areas such as flexibility, strength, cardiovascular health, and mental well-being.

Physical Health Benefits

Yoga has been found to improve flexibility, balance, and strength. (Cramer *et al.*, 2013) conducted a systematic review and meta-analysis on the effects of yoga on physical fitness and found that yoga significantly improved muscle strength, joint flexibility, and overall functional mobility. The practice is particularly beneficial for individuals with limited mobility or those recovering from injury or surgery.

Yoga also has a positive effect on cardiovascular health. A meta-analysis by Cramer et al. (2014) found that yoga interventions significantly reduced blood pressure, improved heart rate variability, and enhanced other markers of cardiovascular health. These findings suggest that yoga may be an effective complementary practice for individuals with hypertension or other cardiovascular conditions.

In addition to flexibility and cardiovascular benefits, yoga has been shown to have positive effects on musculoskeletal health. A study by Harmer and Stroud (2019) found that yoga was effective in reducing chronic back pain and improving function in individuals with musculoskeletal disorders. This benefit is likely due to the emphasis on strengthening and lengthening the muscles, which improves posture and reduces strain on the spine.

Psychological and Emotional Benefits

The psychological benefits of yoga are perhaps the most widely recognized aspect of the practice. Yoga has been shown to reduce stress, anxiety, and depression, and enhance overall well-being. A meta-analysis by Pascoe *et al.*, (2017) found that yoga significantly reduced symptoms of anxiety and depression in clinical populations. This is likely due to the combination of physical movement, breath control, and meditation, all of which have been shown to regulate the nervous system and promote relaxation.

Yoga also promotes mindfulness, which is the ability to be fully present in the moment without judgment. This is a central component of many forms of yoga, particularly those that incorporate meditation and breathwork. Studies have found that mindfulness-based practices, including yoga, can improve emotional regulation, reduce rumination, and increase positive emotions (Gothe *et al.*, 2016). Yoga practitioners often report feeling more emotionally resilient and able to cope with stressors in their daily lives.

Cognitive Benefits

In addition to its emotional and physical benefits, yoga has also been shown to enhance cognitive functioning. Regular yoga practice has been associated with improved attention, memory, and mental clarity. A study by Gothe *et al.* (2016) found that yoga improved hippocampal function, which is critical for learning and memory. These cognitive benefits may be due to the neuroplastic effects of yoga, which help strengthen neural connections in the brain.

Mechanisms Behind Yoga's Benefits

The physiological and psychological benefits of yoga can be attributed to several mechanisms. Yoga's emphasis on breath control and meditation activates the parasympathetic nervous system, which helps reduce the body's stress response and induces a state of relaxation (Field, 2011). The practice of slow, controlled breathing (pranayama) has been shown to increase vagal tone, which regulates heart rate and promotes a sense of calm (Thayer *et al.,* 2012).

Yoga also has a positive effect on the endocrine system. Research has found that yoga can reduce levels of the stress hormone cortisol, which is associated with chronic stress and inflammation. Lower cortisol levels can reduce the risk of stress-related conditions such as cardiovascular disease, obesity, and depression (Pascoe *et al.,* 2017).

On a neurological level, yoga has been shown to increase brain plasticity and enhance the function of brain regions involved in emotional regulation, memory, and attention. Studies have found that regular yoga practice can increase the size of the hippocampus, a brain region associated with learning and memory, and improve overall cognitive functioning (Gothe *et al.,* 2016).

8.5 Challenges in Yoga Research

Despite the growing body of evidence supporting the benefits of yoga, several challenges remain in yoga research. One of the major challenges is the variability of yoga practice. Yoga is highly individualized, with different practitioners following different styles, sequences, and levels of intensity. This makes it difficult to standardize interventions for research purposes and compare results across studies.Additionally, many studies on yoga suffer from small sample sizes, lack of control groups, and short follow-up periods, which can limit the generalizability of findings. Furthermore, much of the existing research is focused on specific populations, such as individuals with chronic pain, mental health conditions, or aging populations. More research is needed on the general population, as well as on the long-term effects of yoga practice.

8.6 Future Directions in Yoga Research

A number of important topics should be the focus of future yoga study. The long-term impacts of yoga on mental and physical health must first be evaluated via bigger, more meticulously planned research.

Determining if yoga's advantages last over time and whether it can be used as a preventative or therapeutic intervention for chronic diseases are two things that longitudinal studies can help with. Second, further investigation is required to examine the ways in which yoga affects mental health. Although yoga has a well-established ability to reduce stress, it is still unknown which precise neurological processes are at play. More specialized treatments for people with anxiety, depression, and other mental health issues may result from an understanding of these systems. Finally, studies should examine how various forms of yoga affect health outcomes. There is less study on more recent forms, including restorative yoga or therapeutic yoga for certain ailments, even if some types, like Hatha or Vinyasa yoga, have been thoroughly examined. (Yang K. 2007).

8.7 Conclusion

Yoga is a complex discipline that has many advantages for mental and physical well-being. In addition to its foundations in ancient Indian philosophy, a growing corpus of contemporary research demonstrates its efficacy in enhancing strength, flexibility, emotional stability, and stress reduction. Yoga is still a useful tool for anyone looking for holistic health practices that balance the body, mind, and spirit as it develops and spreads around the world. Yoga provides a holistic approach to healing by combining mental, spiritual, and physical disciplines. Yoga has been shown to be a successful and easily accessible therapy for a variety of health issues, whether it is utilized as a preventative measure for general well-being or as a supplemental treatment for certain ailments. Yoga offers a comprehensive route to wellness, healing, and health by fusing traditional knowledge with contemporary therapeutic techniques. Always consult with a healthcare provider before beginning a new yoga practice, especially for individuals with pre-existing health conditions. A healthcare professional should always be consulted before starting a new yoga practice, especially for people who already have health issues.

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9

The Influence of Indian Knowledge on the Development of Natural Products for Pharmaceutical Applications

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9.1 Introduction

The rich heritage of Indian traditional knowledge systems, such as Ayurveda, Siddha, and Unani, has profoundly influenced the development of natural products for pharmaceutical applications. These ancient systems, rooted in holistic approaches to health and wellness, have provided a collection of bioactive compounds derived from plants, minerals, and other natural sources. Over centuries, Indian scholars carefully documented the therapeutic properties of these natural products in classical texts like the *Charaka Samhita* and *Sushruta Samhita*, laying the foundation for modern pharmacology (Mukherjee, 2019).The global pharmaceutical industry has increasingly recognized the value of traditional Indian knowledge in drug discovery and development. Natural products, often referred to as "nature's pharmacy," have been significant in the creation of life-saving drugs. For instance, compounds like curcumin from turmeric and vincristine from the periwinkle plant have demonstrated remarkable efficacy in treating various diseases, including cancer and inflammatory disorders (Gupta and Reddy, 2021). These examples underscore the potential of Indian traditional knowledge to address contemporary health challenges.In recent years, advancements in analytical techniques and biotechnology have facilitated the integration of traditional knowledge with modern scientific methodologies. This synergy has enabled the identification, isolation, and characterization of bioactive compounds, paving the way for the development of novel therapeutics (Sharma *et al.,* 2020). Moreover, the emphasis on sustainable and ethical sourcing of natural products aligns with the principles of traditional Indian medicine, ensuring the preservation of biodiversity and cultural heritage (Patwardhan, 2018).Despite these advancements, challenges such as biopiracy, intellectual property rights, and the standardization of traditional formulations persist. Addressing these issues is crucial to unlocking the full potential of Indian knowledge systems in pharmaceutical innovation. This review aims to explore the historical and contemporary contributions of Indian traditional knowledge to the development of natural products, highlighting their significance in the global pharmaceutical landscape.

9.2 Historical Context: How Ancient Indian Texts and Practices Contributed to the Understanding of Natural Products

India's traditional knowledge systems have long been a cornerstone in the understanding and application of natural products for therapeutic purposes. Ancient texts such as the *Charaka Samhita* and *Sushruta Samhita* are among the earliest documented works that systematically describe the medicinal properties of plants, minerals, and animal products. These texts emphasize a holistic approach to health, integrating natural remedies with lifestyle and dietary practices (Kannaiyan, 2007).

The *Atharva Veda*, one of the oldest Indian scriptures, contains hymns and rituals that highlight the use of herbs for healing purposes. Plants like neem (*Azadirachta indica*), turmeric (*Curcuma longa*), and ashwagandha (*Withania somnifera*) are frequently mentioned for their therapeutic properties. These references laid the groundwork for the systematic documentation of medicinal plants in later periods (Bairagee, 2017).

During the medieval period, texts such as the *Bhavaprakasha* expanded on earlier knowledge, incorporating insights from alchemy and mineralogy. The introduction of Unani medicine during the Mughal era further enriched India's pharmacological heritage by blending Greek, Persian, and Indian traditions. This cross-cultural exchange facilitated the development of complex formulations and techniques for drug preparation (Kannaiyan, 2007).

The traditional practices of Siddha medicine, predominantly followed in South India, also contributed significantly to the understanding of natural products. Siddha texts emphasize the use of metals and minerals, alongside herbs, for treating chronic ailments. These practices underscore the diversity and depth of India's traditional medical knowledge (Bairagee, 2017).

The influence of ancient Indian knowledge on global pharmacology became evident during the colonial period when British botanists and physicians documented India's medicinal flora. This led to the identification of bioactive compounds like reserpine from *Rauwolfia serpentina* and vincristine from *Catharanthus roseus*, which have since become integral to modern medicine (Kannaiyan, 2007).

9.3 Pharmacological Insights: Key Natural Products Derived from Indian Knowledge and Their Pharmaceutical Applications

India's traditional knowledge systems, particularly Ayurveda, Siddha, and Unani, have significantly contributed to the discovery and development of natural products with remarkable pharmacological properties. These systems emphasize the use of plants, minerals, and other natural resources for therapeutic purposes, many of which have been validated by modern science.

Neem *(Azadirachta indica*)

Neem has been a cornerstone of traditional Indian medicine for centuries. Its bioactive compounds, such as azadirachtin, nimbin, and nimbidin, exhibit antimicrobial, antifungal, and anti-inflammatory properties. Neem-based formulations are widely used in treating skin disorders, infections, and as natural pesticides. The Neem case also highlighted the importance of protecting traditional knowledge from biopiracy (Madhan and Karthikeyan, 2023).

Turmeric *(Curcuma longa*)

Turmeric, a staple in Indian households, contains curcumin, a compound with potent anti-inflammatory and antioxidant properties. It has been extensively studied for its role in managing conditions such as arthritis, cardiovascular diseases, and neurodegenerative disorders. Turmeric's therapeutic potential underscores the value of traditional knowledge in modern pharmacology (Indian Journal of Traditional Knowledge, 2025).

Ashwagandha *(Withania somnifera*)

Ashwagandha, also known as Indian ginseng, is renowned for its adaptogenic properties. It helps in managing stress, anxiety, and fatigue. Recent studies have also explored its neuroprotective effects, making it a promising candidate for treating neurodegenerative diseases (Indian Journal of Traditional Knowledge, 2025).

Tulsi *(Ocimum sanctum)*

Tulsi, or holy basil, is revered in Ayurveda for its immunomodulatory and antimicrobial properties. Its essential oils, rich in eugenol, have shown efficacy in managing respiratory disorders and infections. Tulsi-based herbal teas and supplements are gaining popularity globally (Kumari, 2023).

Amla *(Phyllanthus emblica)*

Amla, or Indian gooseberry, is a rich source of vitamin C and antioxidants. It is used in traditional medicine for boosting immunity, improving digestion, and managing diabetes. Amla's hepatoprotective properties have also been validated in recent studies (Indian Journal of Traditional Knowledge, 2025).

Table 1: Plant name and their uses

Plant Name	Traditional Use	Pharmaceutical Application	Key Phytochemical	Reference
Rauwolfia serpentina	Treatment of hypertension and mental disorders	Antihypertensive agent	Reserpine	Goyal & Meena (2016)
Withania somnifera	Adaptogen, immune booster, and stress reliever	Treatment of anxiety and neurodegenerative diseases	Withaferin A	Dhama et al. (2018)
Curcuma longa	Anti-inflammatory and digestive aid	Anti-inflammatory and anti-cancer agent	Curcumin	Prasad et al. (2014)
Tinospora cordifolia	Immune modulator and antipyretic	Treatment of diabetes and autoimmune disorders	Tinosporaside	Upadhyay et al. (2010
Azadirachta indica (Neem)	Antibacterial, antifungal, and skin health	Antimicrobial and antiviral agent	Nimbin	Biswas et al. (2002)
Ocimum sanctum (Tulsi)	Treatment of respiratory and digestive issues	Adaptogen and anti-inflammatory agent	Eugenol	Kaur et al. (2004)

9.4 Modern Applications: Integration of Traditional Knowledge with Modern Drug Discovery Techniques

The integration of traditional knowledge with modern drug discovery techniques has opened new avenues for developing innovative and effective therapeutics. India's rich heritage of traditional medicine, including Ayurveda, Siddha, and Unani, has provided a foundation for identifying bioactive compounds and understanding their mechanisms of action. Modern scientific methodologies have further enhanced the potential of these traditional practices.

Ethnopharmacology and Drug Discovery

Ethnopharmacology, the study of traditional medicinal practices, has played a crucial role in bridging the gap between ancient knowledge and modern science. Researchers use traditional knowledge as a guide to identify plants and natural products with therapeutic potential. For instance, the use of neem (*Azadirachta indica*) in traditional medicine has led to the development of neem-based biopesticides and antimicrobial agents (Madhan and Karthikeyan, 2023).

High-Throughput Screening and Bioinformatics

Modern drug discovery techniques, such as high-throughput screening and bioinformatics, have enabled the rapid identification of bioactive compounds from traditional medicinal plants. These technologies allow researchers to analyze large datasets and predict the pharmacological properties of natural products. For example, curcumin from turmeric (*Curcuma longa*) has been extensively studied using computational tools to understand its anti-inflammatory and anticancer properties (Indian Journal of Traditional Knowledge, 2025).

Standardization and Quality Control

One of the challenges in integrating traditional knowledge with modern drug discovery is the standardization of herbal formulations. Advances in analytical techniques, such as chromatography and spectroscopy, have facilitated the quality control of traditional medicines. These methods ensure the consistency, safety, and efficacy of herbal products, making them suitable for global markets (Kumari, 2023).

Synergistic Formulations

Modern science has also explored the synergistic effects of combining traditional herbal remedies with synthetic drugs. This approach enhances the efficacy of treatments while reducing side effects. For instance, the combination of ashwagandha (*Withania somnifera*) with conventional antidepressants has shown promising results in managing stress and anxiety (Madhan and Karthikeyan, 2023).

Sustainable and Ethical Practices

The integration of traditional knowledge with modern drug discovery emphasizes sustainable and ethical practices. Researchers are increasingly focusing on the conservation of medicinal plants and the equitable sharing of benefits with indigenous communities. This approach not only preserves biodiversity but also respects the cultural heritage associated with traditional medicine (Indian Journal of Traditional Knowledge, 2025).

9.5 Challenges and Opportunities

9.5.1 Ethical Issues in Bioprospecting and Intellectual Property Rights

Bioprospecting, the exploration of natural resources for commercially valuable compounds, has raised significant ethical concerns. Traditional Indian knowledge, such as Ayurvedic formulations or the properties of medicinal plants, has often been utilized in pharmaceutical development. However, this raises critical questions about the rights of indigenous communities who have preserved and practiced this knowledge for centuries.Key ethical issues include:

- **Benefit Sharing:** Indigenous communities often receive minimal or no benefits from the commercialization of their traditional knowledge. This highlights the need for equitable benefit-sharing mechanisms (Javia, 2023).
- **Misappropriation of Knowledge:** Instances of “biopiracy,” where patents are granted for discoveries rooted in traditional knowledge without proper attribution, have sparked global debate. For example, the patenting of turmeric and neem has been contentious (EduKemy, 2024).
- **Lack of Legal Frameworks:** While India has established frameworks like the Biological Diversity Act (2002), gaps remain in international enforcement and recognition of traditional knowledge (Javia, 2023).

Efforts to address these issues involve creating robust legal frameworks, ensuring prior informed consent, and promoting fair-trade practices in pharmaceutical development.

9.5.2 Challenges in Standardization and Clinical Validation

One of the significant barriers to integrating traditional knowledge into modern pharmaceuticals is the lack of standardization and clinical validation:

- **Complexity of Formulations:** Traditional systems like Ayurveda often utilize polyherbal formulations, making it challenging to isolate active compounds for study (Mandal *et al.,* 2021).
- **Lack of Standardized Processes:** Variability in plant sources, cultivation, and preparation methods leads to inconsistencies in potency and efficacy (Prakash, 2009).
- **Rigorous Clinical Testing:** Many traditional remedies lack the level of clinical evidence required by modern regulatory standards. Despite their historical use, many Ayurvedic medicines have not undergone randomized controlled trials to meet global pharmaceutical norms (Mandal *et al.,* 2021).

Addressing these challenges calls for collaboration between traditional practitioners, pharmacologists, and regulatory bodies to establish standardization protocols and ensure scientific validation.

9.5.3 Opportunities for Collaboration Between Traditional Knowledge Systems and Modern Science

While challenges persist, the intersection of traditional knowledge and modern science offers immense opportunities:

- **Bioprospecting and Reverse Pharmacology:** Reverse pharmacology leverages traditional knowledge to identify promising leads, expediting the drug discovery process. For instance, Ashwagandha (Withania somnifera) and its adaptogenic properties have attracted significant research interest (PolSci Institute, 2024).
- **Integration of Traditional and Modern Practices:** Collaborative research programs can bridge the gap between traditional systems and cutting-edge science. Institutions like the Indian Council of Medical Research (ICMR) and Central Council for Research in Ayurvedic Sciences (CCRAS) have initiated such programs (Satoyama Initiative, 2024).
- **Global Recognition and Commercialization:** The global market for herbal medicines is on the rise, presenting an opportunity to bring Indian medicinal products to international platforms, provided they meet regulatory standards (PolSci Institute, 2024).

- **Sustainability and Conservation:** Collaboration encourages the sustainable use of biodiversity, ensuring the preservation of both medicinal plants and indigenous knowledge for future generations (Satoyama Initiative, 2024).

9.6 Conclusion

Indian traditional knowledge systems, such as Ayurveda, Siddha, and Unani, have profoundly influenced the development of natural products for pharmaceutical applications. These systems, rooted in centuries of empirical wisdom, have provided a treasure trove of medicinal plants and formulations that continue to inspire modern drug discovery. For instance, the isolation of reserpine from *Rauwolfia serpentina* and the identification of curcumin from *Curcuma longa* (turmeric) are prime examples of how traditional knowledge has contributed to the development of globally recognized therapeutic agents (Mandal *et al.,* 2021).

The integration of traditional knowledge into modern pharmaceutical research has been facilitated by methodologies such as reverse pharmacology, which leverages historical usage data to identify promising leads for drug development. This approach not only accelerates the discovery process but also reduces the risk of adverse effects, as the safety profiles of many traditional remedies are well-documented (Patwardhan *et al.,* 2005).

Moreover, the global demand for herbal medicines and natural products has surged in recent years, driven by a growing preference for holistic and sustainable healthcare solutions. India, with its rich biodiversity and extensive repository of traditional knowledge, is uniquely positioned to lead this burgeoning market. However, the full potential of Indian knowledge systems remains untapped due to challenges such as the lack of standardization, clinical validation, and intellectual property protection (Bhardwaj *et al.,* 2018).

9.7 Future Prospects and Potential

The future of Indian traditional knowledge in pharmaceutical applications is promising, provided that certain strategic measures are implemented. Here are some key areas of focus:

- **Standardization and Quality Control** To gain wider acceptance in global markets, Indian herbal medicines must meet stringent quality standards. This includes the standardization of raw materials, extraction processes, and final formulations.

Advances in analytical techniques, such as high-performance liquid chromatography (HPLC) and mass spectrometry, can play a pivotal role in ensuring consistency and efficacy (Bhosale *et al.*, 2023).

- **Clinical Validation and Evidence-Based Research** The integration of traditional remedies into mainstream medicine requires robust clinical evidence. Randomized controlled trials (RCTs) and meta-analyses are essential to validate the safety and efficacy of traditional formulations. Collaborative research initiatives involving traditional practitioners, pharmacologists, and clinical researchers can bridge the gap between empirical knowledge and scientific validation (Bhardwaj *et al.*, 2018).
- **Ethical Bioprospecting and Intellectual Property Rights** Ethical bioprospecting practices are crucial to ensure that the benefits of pharmaceutical developments are equitably shared with indigenous communities. Strengthening intellectual property frameworks and promoting fair-trade practices can protect traditional knowledge from exploitation and foster sustainable development (Mandal *et al.*, 2021).
- **Global Collaboration and Market Expansion** India has the potential to become a global leader in the herbal medicine market by fostering international collaborations and adhering to global regulatory standards. Initiatives such as the World Health Organization's Traditional Medicine Strategy can provide a platform for the global recognition of Indian knowledge systems (Bhosale *et al.*, 2023).
- **Sustainability and Conservation** The sustainable use of medicinal plants is essential to preserve biodiversity and ensure the long-term availability of natural resources. Community-based conservation programs and the cultivation of medicinal plants can mitigate the impact of overharvesting and habitat destruction (Bhardwaj *et al.*, 2018).
- **Technological Integration** The application of cutting-edge technologies, such as artificial intelligence (AI) and machine learning, can revolutionize the field of natural product research. These technologies can analyze vast datasets to identify novel bioactive compounds and predict their pharmacological properties, thereby accelerating the drug discovery process (Patwardhan *et al.*, 2005).

In conclusion, the rich heritage of Indian traditional knowledge offers immense potential for the development of innovative and sustainable pharmaceutical solutions. By addressing existing challenges and leveraging modern scientific advancements, India can not only preserve its cultural legacy but also contribute significantly to global healthcare. The synergy between traditional wisdom and modern science holds the promise of a healthier and more sustainable future.

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10

Homeopathic Remedies and its Origins in Managing Various Disorder

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10.1 Introduction

Homeopathy, founded by Samuel Hahnemann in the late 18th century, is a holistic treatment approach that emphasizes individualized care (Vithoulkas, 2010). The homeopathic philosophy posits that diseases result from imbalances in the body's vital force, and treatment aims to restore harmony by stimulating the body's self-healing mechanisms. Homeopathic medicines are derived from plant, mineral, and animal sources, often prepared in minute quantities to avoid toxicity. This paper reviews the use of homeopathic remedies for several common chronic conditions, illustrating their sources, mechanisms, and effectiveness (Bhatia, *et al.,* 2017).

Homeopathic Remedies for Various Disorders

10.2.1 Diabetes and Homeopathy

Diabetes mellitus is a metabolic disorder characterized by high blood glucose levels resulting from insufficient insulin production or ineffective insulin action. In homeopathy, treatment is focused on regulating blood sugar levels and improving overall metabolic function. Homeopathic remedies are prescribed based on the individual's symptoms, lifestyle, and overall health (Witt, *et al.,* 2013).

Diabetes is a chronic medical condition that occurs when the body is unable to properly regulate blood sugar (glucose) levels. This happens either because the body does not produce enough insulin (a hormone produced by the pancreas that helps regulate blood sugar) or because the body's cells become resistant to the effects of insulin. As a result, high levels of glucose can build up in the bloodstream, which can lead to various health complications over time (Buchanan, *et al.*, 2016).

There are two main types of diabetes:

- **Type 1 Diabetes:** An autoimmune condition where the immune system attacks and destroys the insulin-producing cells in the pancreas. This leads to little or no insulin production. It typically develops in childhood or early adulthood and requires lifelong insulin therapy.
- **Type 2 Diabetes:** This is the most common form of diabetes, where the body either does not produce enough insulin or the cells become resistant to it. It is often linked to lifestyle factors, such as poor diet, lack of exercise, and obesity. Type 2 diabetes typically develops in adulthood but can occur at any age.

There is also gestational diabetes, which occurs during pregnancy and usually resolves after childbirth, but it increases the risk of developing Type 2 diabetes later in life.

Symptoms of Diabetes:

- Frequent urination
- Increased thirst and hunger
- Fatigue
- Unexplained weight loss
- Blurred vision
- Slow healing of wounds
- Tingling or numbness in hands or feet

If left untreated, diabetes can lead to serious complications, including heart disease, kidney damage, nerve damage, and vision problems.

Managing diabetes typically involves lifestyle changes, regular monitoring of blood sugar levels, a balanced diet, exercise, and in some cases, medication or insulin therapy.

Common Homeopathic Remedies for Diabetes

- **Syzygium Jambolanum:** Derived from the Jamun fruit, this remedy is often used to manage high blood sugar and frequent urination.

- **Phosphoric Acid:** Indicated for diabetes with fatigue and weakness, often used in cases of late-stage diabetes.
- **Insulin:** A homeopathic preparation of insulin, often used in treating diabetic symptoms where insulin resistance is a factor.

Sources

- **Syzygium Jambolanum:** A plant native to India, commonly known as Java plum or black plum.
- **Phosphoric Acid:** A mineral acid derived from phosphorus.

10.2.2 Homeopathic Remedies for Hyperacidity

Hyperacidity, also known as acid reflux or gastroesophageal reflux disease (GERD), is a condition where there is an excessive production of stomach acid, which can irritate the lining of the stomach and the esophagus. It often leads to symptoms such as heartburn, indigestion, and discomfort in the upper abdomen (Hahnemann, 2000).

Causes of Hyperacidity

Hyperacidity can result from various factors, including:

- **Dietary habits:** Consuming spicy, fatty, or acidic foods, carbonated drinks, or excessive caffeine can trigger acid production.
- **Stress:** High stress levels can lead to increased acid secretion in the stomach.
- **Obesity:** Being overweight can put pressure on the stomach, increasing the likelihood of acid reflux.
- **Smoking and alcohol consumption:** Both smoking and alcohol can relax the lower esophageal sphincter, allowing acid to move into the esophagus.
- **Medications:** Certain medications, such as painkillers (NSAIDs), can irritate the stomach lining.
- **Hiatal hernia:** A condition where a part of the stomach pushes through the diaphragm into the chest, making acid reflux more likely.
- **Pregnancy:** Hormonal changes and the pressure exerted by the growing uterus can contribute to acid reflux.

Symptoms of Hyperacidity

- **Heartburn:** A burning sensation in the chest, usually after eating, which may worsen when lying down or bending over.
- **Regurgitation:** Sour or bitter-tasting acid backing up into the throat or mouth.

- **Bloating and gas:** Feeling full or bloated after eating, accompanied by excessive gas.
- **Nausea:** A feeling of queasiness, especially after eating.
- **Sore throat or hoarseness:** Due to the acid irritating the esophagus.
- **Difficulty swallowing:** A sensation of food being stuck in the throat.

Treatment for Hyperacidity

- **Dietary modifications:** Avoiding trigger foods and beverages, eating smaller meals, and not lying down immediately after eating.
- **Antacids:** Over-the-counter medications that neutralize stomach acid and provide relief from heartburn.
- **Proton pump inhibitors (PPIs) and H2 blockers:** These drugs reduce the production of stomach acid.
- **Lifestyle changes:** Maintaining a healthy weight, quitting smoking, reducing alcohol consumption, and managing stress.
- **Surgery:** In severe cases, surgical options like fundoplication may be considered to strengthen the lower esophageal sphincter.

If symptoms of hyperacidity persist or worsen, it is essential to consult a healthcare provider to prevent complications such as ulcers, esophagitis, or long-term damage to the esophagus.

Hyperacidity and Homeopathy

Hyperacidity, also known as acid reflux or gastroesophageal reflux disease (GERD), involves excess stomach acid causing discomfort, heartburn, and other digestive issues. Homeopathic remedies for hyperacidity focus on balancing stomach acid production and soothing the digestive system (Sharma, *et al.,* 2014).

Common Homeopathic Remedies for Hyperacidity

- **Nux Vomica:** Derived from the seeds of the Strychnos Nux-vomica tree, this remedy is useful for acidity, nausea, and indigestion, especially in people who have a sedentary lifestyle or a tendency to overeat.
- **Arsenicum Album:** A mineral-based remedy helpful for burning sensations in the stomach, often used when hyperacidity is accompanied by anxiety.
- **Carbo Veg:** Derived from vegetable charcoal, Carbo Veg is used for indigestion, bloating, and a feeling of fullness.

Sources

- **Nux Vomica:** Seeds from the Strychnos Nux-vomica tree, native to Southeast Asia.
- **Arsenicum Album:** An element of arsenic, though prepared in a highly diluted form.
- **Carbo Veg:** Charcoal from vegetable sources, often from wood or plants.

9.2.3 Homeopathic Remedies for PCOD (Polycystic Ovarian Disease)

Polycystic Ovarian Disease is a hormonal disorder that causes irregular menstrual cycles, excess androgen production, and cysts in the ovaries. Homeopathy offers remedies that aim to regulate hormonal imbalances, improve ovarian function, and reduce associated symptoms like weight gain, acne, and excessive hair growth.

PCOD (Polycystic Ovarian Disease), also known as PCOS (Polycystic Ovary Syndrome), is a common hormonal disorder that affects people with ovaries, typically during their reproductive years. It is characterized by a variety of symptoms, including irregular menstrual cycles, excessive levels of male hormones (androgens), and the presence of cysts in the ovaries (Hathi, *et al.,* 2018).

Key Features of PCOD:

- **Irregular Periods:** People with PCOD often have infrequent, irregular, or prolonged menstrual cycles. Some may experience very few periods each year, while others may have heavy or prolonged bleeding.
- **Excess Androgens:** Elevated levels of male hormones, or androgens, can lead to symptoms like excessive hair growth (hirsutism), acne, and male-pattern baldness.
- **Ovarian Cysts:** The ovaries may contain multiple small cysts (fluid-filled sacs) that can be seen on ultrasound. These cysts are immature follicles that have not been released during ovulation.

Symptoms of PCOD:

- Irregular or missed periods
- Difficulty getting pregnant (infertility) due to ovulation problems
- Excessive hair growth on the face, chest, or abdomen (hirsutism)
- Acne and oily skin
- Thinning hair or male-pattern baldness
- Weight gain or difficulty losing weight

- Darkening of the skin, especially around the neck, armpits, and groin
- Mood swings or depression due to hormonal imbalances

Causes of PCOD:

The exact cause of PCOD is not fully understood, but several factors may contribute to the condition:

- **Genetics:** PCOD tends to run in families, suggesting a genetic predisposition.
- **Insulin Resistance:** Many individuals with PCOD have insulin resistance, where the body does not respond well to insulin. This leads to higher insulin levels, which can trigger the ovaries to produce more androgens.
- **Hormonal Imbalance:** An imbalance in hormones, including increased levels of androgens and luteinizing hormone (LH), can affect the normal functioning of the ovaries.

Complications of PCOD:

- **Infertility:** Due to irregular ovulation, PCOD can make it harder to conceive.
- **Type 2 Diabetes:** The insulin resistance that is common in PCOD increases the risk of developing type 2 diabetes.
- **Endometrial Cancer:** Irregular menstrual cycles and lack of ovulation can increase the risk of endometrial cancer due to prolonged exposure to estrogen without the balancing effect of progesterone.
- **Cardiovascular Issues:** PCOD is linked with an increased risk of heart disease and high cholesterol.

Treatment for PCOD:

While there is no cure for PCOD, treatments focus on managing symptoms and preventing complications. These include:

- **Hormonal Birth Control:** Birth control pills can regulate menstrual cycles, reduce excess hair growth, and clear acne.
- **Metformin:** A medication that helps with insulin resistance and may help in regulating periods and improving fertility.
- **Anti-androgen Medications:** Drugs like spironolactone can help reduce excess hair growth and acne.
- **Lifestyle Modifications:** Weight management, a healthy diet, and regular exercise can help improve symptoms, especially in managing insulin resistance and preventing weight gain.
- **Fertility Treatments:** If pregnancy is desired, medications like clomiphene citrate may be used to stimulate ovulation, or

assisted reproductive technologies (ART) like in vitro fertilization (IVF) may be considered.

Common Homeopathic Remedies for PCOD

- **Sepia:** Derived from the ink of the cuttlefish, Sepia is often used for hormonal imbalances, particularly in women with irregular periods, mood swings, and lack of energy.
- **Pulsatilla:** Derived from the Anemone patens plant, Pulsatilla is used for women with mood swings, emotional instability, and irregular periods.
- **Natrum Muriaticum:** A remedy for women who experience emotional stress, particularly those who have irregular cycles associated with emotional factors.

Sources

- **Sepia:** The ink from the cuttlefish, a marine creature.
- **Pulsatilla:** The flowering plant, Anemone patens.
- **Natrum Muriaticum:** Common salt (sodium chloride).

10.2.4 Homeopathic Remedies for Thyroid Disorders

Thyroid disorders, such as hypothyroidism and hyperthyroidism, involve the abnormal production of thyroid hormones. Homeopathy aims to address the underlying causes of thyroid imbalance, whether through stress, autoimmune factors, or nutrient deficiencies.Thyroid refers to a butterfly-shaped gland located at the base of the neck, just below the Adam's apple. It is part of the endocrine system and plays a crucial role in regulating the body's metabolism through the production of hormones (Lee, *et al.,* 2018).

The thyroid gland produces two primary hormones:

- **Thyroxine (T4):** The main hormone produced by the thyroid, which is converted into the more active hormone triiodothyronine (T3) in various tissues.
- **Triiodothyronine (T3):** The active form of thyroid hormone, responsible for regulating metabolic processes in the body.

These hormones control various bodily functions, including heart rate, body temperature, and energy production. They also influence the growth and development of the body and help regulate the use of nutrients.Thyroid disorders occur when the thyroid gland produces too much or too little of these hormones, leading to either hyperthyroidism (overactive thyroid) or hypothyroidism (underactive thyroid).

- **Hyperthyroidism:** This condition occurs when the thyroid gland produces too much thyroid hormone, leading to an accelerated metabolism. Symptoms include:
    - Weight loss despite increased appetite
    - Rapid or irregular heartbeat (palpitations)
    - Tremors (shaking hands)
    - Excessive sweating and heat intolerance
    - Anxiety or irritability
    - Fatigue or muscle weakness
    - Difficulty sleeping

The most common cause of hyperthyroidism is Graves' disease, an autoimmune disorder that causes the thyroid to become overactive.

- **Hypothyroidism:** This condition occurs when the thyroid gland produces insufficient thyroid hormone, slowing down the metabolism. Symptoms include:
    - Weight gain despite a normal appetite
    - Fatigue and sluggishness
    - Cold intolerance
    - Dry skin and hair, hair loss
    - Depression
    - Constipation
    - Muscle weakness and joint pain

The most common cause of hypothyroidism is Hashimoto's thyroiditis, an autoimmune disorder where the immune system attacks the thyroid gland, leading to its gradual destruction.

Diagnosis and Treatment

Thyroid conditions are diagnosed through blood tests that measure the levels of thyroid hormones (T3, T4) and thyroid-stimulating hormone (TSH), which is produced by the pituitary gland to regulate thyroid activity.

Treatment for thyroid disorders may include:

- **Medications:** For hypothyroidism, thyroid hormone replacement therapy (e.g., levothyroxine) is prescribed. For hyperthyroidism, antithyroid medications or beta-blockers may be used.
- **Radioactive iodine therapy:** Used to treat hyperthyroidism by shrinking the thyroid tissue.

- **Surgery:** In cases of large goiters, thyroid cancer, or when other treatments are ineffective, surgical removal of part or all of the thyroid gland may be necessary.

Proper diagnosis and treatment are essential to managing thyroid disorders and preventing complications such as heart problems, infertility, and bone loss.

Common Homeopathic Remedies for Thyroid Disorders

- **Thyroidinum:** A remedy made from thyroid glandular tissue, often used for both hypothyroidism and hyperthyroidism.
- **Calcarea Carbonica:** Derived from the oyster shell, this remedy is often used for hypothyroid symptoms like fatigue and weight gain.
- **Iodium:** A remedy used for hyperthyroid conditions, including weight loss, excessive sweating, and heat intolerance.

Sources

- **Thyroidinum:** Derived from thyroid glandular tissue, often sourced from animals.
- **Calcarea Carbonica:** The shell of marine mollusks.
- **Iodium:** Iodine, a trace element commonly sourced from seaweed.

10.2.5 Homeopathic Remedies for Hypertension

Hypertension, also known as high blood pressure, is a medical condition in which the force of the blood against the walls of the arteries is consistently too high. Blood pressure is measured in millimeters of mercury (mmHg) and is expressed in two numbers: systolic and diastolic pressure.

- **Systolic Pressure:** The higher number, representing the pressure in the arteries when the heart beats and pumps blood.
- **Diastolic Pressure:** The lower number, representing the pressure in the arteries when the heart is at rest between beats.

A normal blood pressure reading is typically around 120/80 mmHg. Hypertension is generally defined as having a blood pressure consistently higher than 130/80 mmHg (Herbert, 2019).

Types of Hypertensions

- **Primary (Essential) Hypertension:** This is the most common type of hypertension and develops gradually over many years. The exact cause is often unknown but is thought to involve a combination of genetic, environmental, and lifestyle factors.

- **Secondary Hypertension:** This type of hypertension is caused by an underlying condition, such as kidney disease, sleep apnea, or hormonal disorders. It can also be caused by the use of certain medications, such as birth control pills, decongestants, or pain relievers.
- **White Coat Hypertension:** This occurs when a person's blood pressure is elevated in a medical setting (due to anxiety or stress) but is normal at other times.

Causes and Risk Factors

The exact cause of primary hypertension is often unclear, but several factors may contribute to the condition:

- **Genetics:** A family history of hypertension increases the risk.
- **Age:** Blood pressure tends to increase with age due to the stiffening of the arteries.
- **Obesity:** Excess weight can increase the strain on the heart and lead to higher blood pressure.
- **Lack of Physical Activity:** Sedentary lifestyles can contribute to weight gain and increased blood pressure.
- **High Salt (Sodium) Intake:** Consuming too much salt can lead to fluid retention and increased blood pressure.
- **Excessive Alcohol Consumption:** Drinking too much alcohol can raise blood pressure.
- **Smoking:** Tobacco use can damage blood vessels and increase blood pressure.
- **Chronic Stress:** Long-term stress can contribute to the development of high blood pressure.
- **Sleep Apnea:** Untreated sleep apnea is linked to higher blood pressure.

Symptoms of Hypertension

Hypertension is often called a "silent killer" because it typically does not present noticeable symptoms until it has caused significant damage. However, some individuals may experience:

- Headaches
- Dizziness or lightheadedness
- Shortness of breath
- Chest pain
- Nosebleeds

- Blurred vision
- Fatigue

Since hypertension is usually asymptomatic, regular blood pressure monitoring is essential, especially for those at risk.

Complications of Hypertension

If left untreated, hypertension can lead to serious health problems, including:

- **Heart Disease:** High blood pressure can cause coronary artery disease, heart failure, or heart attacks.
- **Stroke:** Hypertension can lead to the rupture or blockage of blood vessels in the brain, causing a stroke.
- **Kidney Damage:** High blood pressure can damage the kidneys' blood vessels, leading to kidney failure.
- **Vision Loss:** Hypertension can damage the blood vessels in the eyes, leading to vision problems or blindness.
- **Aneurysm:** Weakened blood vessels due to high blood pressure can develop into an aneurysm, which may rupture and cause life-threatening bleeding.

Diagnosis of Hypertension

Hypertension is diagnosed through regular blood pressure measurements using a sphygmomanometer (blood pressure cuff). Blood pressure is measured at least twice, several minutes apart, on different occasions to confirm the diagnosis (Scholten, 2009).

- **Normal blood pressure:** Below 120/80 mmHg
- **Elevated blood pressure:** Systolic between 120-129 mmHg and diastolic less than 80 mmHg
- **Hypertension Stage 1:** Systolic between 130-139 mmHg or diastolic between 80-89 mmHg
- **Hypertension Stage 2:** Systolic of 140 mmHg or higher or diastolic of 90 mmHg or higher

Treatment of Hypertension

The goal of treatment is to reduce blood pressure to a safe level and prevent complications. Treatment options may include:

Lifestyle Modifications:

- **Diet:** Adopting a healthy diet like the DASH (Dietary Approaches to Stop Hypertension) diet, which focuses on fruits, vegetables, whole grains, and low-fat dairy, while limiting sodium, red meat, and sugar.

- **Exercise:** Regular physical activity (e.g., walking, swimming, cycling) can help lower blood pressure.
- **Weight Management:** Losing excess weight can significantly lower blood pressure.
- **Limiting Alcohol:** Reducing alcohol intake can help manage blood pressure.
- **Quit Smoking:** Smoking cessation is important for heart and vascular health.
- **Stress Reduction:** Techniques like meditation, deep breathing, or yoga can help lower stress levels and blood pressure.
- **Medications:** If lifestyle changes are not sufficient, medications may be prescribed to help manage blood pressure. Common types of antihypertensive medications include:
- **Diuretics:** Help reduce excess fluid in the body.
- **ACE Inhibitors (Angiotensin-Converting Enzyme Inhibitors):** Help relax blood vessels.
- **Beta-Blockers:** Reduce the heart rate and the workload on the heart.
- **Calcium Channel Blockers:** Relax and widen blood vessels.
- **Angiotensin II Receptor Blockers (ARBs):** Help relax blood vessels and reduce the risk of complications.

Hypertension and Homeopathy

Hypertension, or high blood pressure, is a chronic condition that can lead to cardiovascular complications. Homeopathy aims to reduce stress, balance hormones, and support overall cardiovascular health, often by focusing on lifestyle and emotional factors.

Common Homeopathic Remedies for Hypertension

- **Crataegus Oxyacantha:** Made from the hawthorn plant, Crataegus is beneficial for improving heart health and reducing high blood pressure (Singh, 2016).
- **Baryta Carbonica:** A remedy used for hypertension associated with aging and arteriosclerosis.
- **Natrum Muriaticum:** For hypertension caused by emotional stress and anxiety.

Sources

- **Crataegus Oxyacantha:** The hawthorn plant.

- **Baryta Carbonica:** A mineral form of barium carbonate.
- **Natrum Muriaticum:** Sodium chloride (common salt).

10.2.6 Homeopathic Remedies for Stress, Anxiety, And Depression

Stress, Anxiety, and Depression and Homeopathy

Homeopathy offers a holistic approach to mental health, aiming to balance the mind-body connection. Remedies for stress, anxiety, and depression address both physical and emotional symptoms (Kaur, *et al.,* 2015).

Common Homeopathic Remedies for Stress, Anxiety, and Depression

- **Aconitum Napellus:** Derived from the monkshood plant, Aconitum is useful for acute anxiety and panic attacks, often with a sudden onset of fear or restlessness (Muller, *et al.,* 2020).
- **Ignatia Amara:** Derived from the seeds of the St. Ignatius bean, Ignatia is used for emotional stress, grief, and mood swings.
- **Natrum Muriaticum:** Often used for those who internalize stress and suffer from depression linked to emotional trauma.

Sources

- **Aconitum Napellus:** The monkshood plant (Aconitum).
- **Ignatia Amara:** The seeds of the St. Ignatius bean (Ignatia amara).
- **Natrum Muriaticum:** Sodium chloride.

10.3 CONCLUSION

Homeopathic remedies, based on the principle of individualized treatment, offer potential benefits for a wide range of chronic conditions such as diabetes, hyperacidity, PCOD, thyroid disorders, hypertension, and mental health issues like stress, anxiety, and depression. These remedies are derived from various natural sources, including plants, minerals, and animal products, and are prepared in highly diluted forms to ensure safety. While homeopathy may not be a substitute for conventional medicine, its role as a complementary therapy is gaining recognition, particularly for patients seeking holistic treatment options. However, it is crucial for patients to consult with healthcare providers before beginning any homeopathic treatment, as individual responses may vary. Further research and clinical trials are necessary to better understand the mechanisms and efficacy of homeopathic remedies.

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11

The Traditional Indian Herbal Drugs Journey, Comprehensive Review – Past, Present and Future Perspectives

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11.1 Introduction

This is year 2025 and all of us are living in a so-called well-advanced society. The information technology is progressing from 2G to 3G, 4G and 5G, now. 6G is shortly coming. At one side, Mankind is advancing at a very fast pace and talks about shifting to planet Mars, for living there.

On the other side, on planet Earth, there are so many challenges, mankind is facing today. Some of them are newer diseases like Corona, AIDS, Cancer, Tuberculosis etc. The other challenges of mankind are - Food, Hunger, Cyclone, Earthquake and wars between countries.

In this paper, we shall discuss the traditional Indian Herbal Drugs Journey, Comprehensive Review – Past, Present and Future Perspectives. Starting from Ayurveda to present scenario, how the herbal drugs are developed, how various Governments and their nodal agencies tries to frame various policies for further restore Indian Herbal products, their due place and respect in the mind of Doctors and Patients.

Although the newer method of treatment i.e. Allopathy conquers many diseases, which were not curable in past. Like in last century

Antibiotics, Antifungal, Antiviral, Antiretroviral drugs, drugs for plague, Parkinsonism, Alzheimer's disease, Urinary Tract Infections, Gonorrhea, Syphilis, Malaria, Dengue, Jaundice etc.

In this Century, lot of drug resistance is seen and cases of patients, which are not cured with existing drugs, are rising at a faster pace. This may be due to resistance of patient's body with existing drugs, due to indiscriminate, irrational usage of drugs and lack of invention of newer drugs.

Although the money that, we are spending on research and development of new drugs are many folds of money that we spent in previous century; at present, advanced technology is available at our end, like latest sophisticated analytical equipment, instruments like UV, IR, FTIR, HPLC, NMR etc. The other newer technologies like Computer Aided Drug Design (CADD) System, Artificial Intelligence and Robotics are also there.

Moreover, at present, Government of India and its Nodal Agency like University Grant Commission (UGC), NAAC, AICTE and other apex bodies and all Universities of Higher Education are emphasizing on Research and Development work pertaining to practical utility of Indian Herbal Drugs to human beings.

The Pharmacy Council of India, Ministry of AYUSH, CCIM also align with UGC and stressed the most on newer drug development and quality education in higher education programmes involving Research and Development of new Drugs from Indian Herbs as well as their extracts, isolated drug moieties, synthetic, chemical APIs. (Poduri, 2021; Patwardhan and Khambholja, 2011)

There is higher rate of failure with synthetic drugs, chemicals APIs, in efficacy of treatment of newer or existing diseases. Since last 50 Years, very few newer chemical moieties are discovered, The Research and Development are going on at full swing all over the world and India, but very few new drugs moieties / molecules are discovered. Failure rates are very high. So, the Researchers, Universities with Higher Education in Pharmacy, AYUSH, CCIM, UGC, AICTE, look with great hope towards the Gold Standards of Drugs. Here comes the role of Indian Knowledge System (Ayurveda, Pharmacognosy and Phytochemistry, precisely).

Since time immemorial, Indian Herbal Medicines always attract the Mankind for new drug, discovery and development. So many ancient granths, Vedas are there; which are quoted for treatment of various diseases and disorders. These are mentioned in Ayurveda - one of the oldest methods of treatment of human diseases. (Yu and Tham, 2024). The modern type of treatment, Allopathy, tries to further improve the ayurvedic drugs limitations, like taste, bioavailability, bioequivalence, biosafety etc. Although in Allopathy, various drugs are synthesized in laboratories, but their increased side effects, toxicity, resistance problem and inefficacy in treating various diseases and disorders, keeps the interest and hope for scope of drugs from Indian Herbs.

11.2 Past History of Traditional Indian Herbal Medicine

If we see history, about 5000 years ago, Ayurveda was started. In India, the traditional system of medicine was Ayurveda. Initially and originally, it was practiced in oral tradition in Guru- Shishya Parampara / tradition for thousands of years and then it was documented in Sanskrit language.

About 3000 - 2500 B.C. Rigveda came, and about 1200 – 1000 B.C., Yajurveda, Samaveda and Attharvaveda came to existence. (Singh, 2025, Majaz and Khurshid, 2016).

In traditional Indian Knowledge System, the first documented evidence was found as Charaka Samhita (1000B.C.) and Sushruta Samhita, dated back to 6-7 century B.C. It contains 341 and 516 drugs respectively. (Newman *et. al.,* 1999)

The traditional Indian medicine system of India had the basis of plants, since thousands of years (Dev, 1999). There were detailed descriptions of more than 1500 herbs and over 10000 drug formulations. In 800 A.D., more than 5000 signs and symptoms were detailed in Madhav Nidan (Majaz and Khurshid, 2016).

11.3 Dark Phase of Traditional Indian Herbal Medicines

During British regime, colonial era, these Ayurvedic, Unani ways of treatment were considered inferior and allopathy was promoted. Previously the doctors using herbal medicines, Vaidyas were considered as Quacks and many times legal proceedings were also done against them.

Our forefathers follow plant based medicines and had treatment of various serious diseases. Only lacunae were that they were not documented properly, published or in written form.

In last century, after 1900 A.D., the scientists start working on plant extracts in western countries. Around 25% of allopathy prescription products are plant based ingredients. (Pandey *et. al.,* 2011).

After freedom from British Rule, after independence, Ayurveda role gained importance once again. Recently studies show that the herbal remedies are shown to be as effective as Allopathic medicines. (Gera *et. al.,* 2017)

As per World Health Organization (W.H.O.), 80% of world's population uses traditional medicines in their primary health care. For rest of 20% population also, plant based drugs play important role.

In U.S. (from 1959 to 1980) about 25% prescriptions are based on plant based products. About 119 chemical substances which are obtained from 90 plants are important drugs.

Out of these 119 drugs, 74% drugs were discovered by doing research work on plants. (Arvigo and Balick, 1993). Plants based drugs lead new drug development (Hossain *et. al.,* 2022, El-Saadony *et. al.,* 2021).

Another WHO report says, almost 80% patients still use herbal medicines. There are 122 plants based drugs (Wu *et. al.,* 2020).

11.3.1 Indian Perspectives

In 1940, the Drugs and Cosmetic Statute and in 1959, the Drug and Cosmetic Rule was revised. In 1940, Government permits conventional and alternative medicines in India. In 1962, Government of India acknowledges the first committee. In 1969, the Ayurvedic, Unani and Siddha were first incorporated as independent chapter, under Act 13 of 1964. In 1983, 1987, 1994 and 2002, these chapters are further updated.

In 1970, the Central Council of Indian Medicine (CCIM) was established. It was made in-charge and responsible for preparing syllabus and curriculum of Unani, Ayurveda and Siddha Education in India. Sowa Rigpa medical system was incorporated by CCIM in 2012. In 2013, the department of AYUSH was renamed. But a separate AYUSH Ministry was made in 2014. (Bhosale *et.al.,* 2023).

Ayurveda study was further divided into 8 branches: General Medicine –Kaya Chikitsa, Surgery – Shalya, Psychiatry - Bhutha Vidya, Paediatrics – Kaumara Bhruthya, ENT and Ophthalmology and Dentistry – Salakya, Toxicology – Agada Tantra, Sexual Vitality – Vajeekarana and Rejuvenation Therapy - Rasayana (Goyal *et.al.,* 2012)

In 2013, out of total drugs market of 934.8 billion dollars, Indian herbal pharmaceuticals constitute only 50.9 billion dollars (Pan *et. al.,* 2013).

As per, AYUSH (Ayurveda, Yoga, Unani, Sidha and Homeopathy), Indian Drugs export has only 3% drugs from herbal products. Out of this 70% includes raw material. 30% includes herbal extracts. If we compared world export, Indian herbal products exports contribute only 1%. (Sahoo and Manchikanti, 2013).

The image and confidence of people regarding Indian herbal drugs, all over the world is increasing day by day and in 2010, ASSOCHAM (The Associated Chambers of Commerce and Industry of India) projected that by 2015, Indian herbal industry will grow to 150 billion rupees. (ASSOCHAM, 2010).

11.4 Current Status of Traditional Indian Herbal Drugs

Presently, many drugs extracted from herbal plants are used as drugs. Some of the most commonly used drugs are as under:

- Anti bacterials- Beta lactams (Penicillin G and Penicillin V), source is *Penicillinium notatum, Penicillinium aspergillus (fungus)*.
- Cephalosporin's source is *Cephalosporium acremonium*(Fungus).
- Aminglycoside's, Streptomycin source is *Streptomyces griseus.*
- Tetracycline source is *Streptomyces sps.*
- Macrolides source is *Streptomyces sps.*
- Antifungal, Amphotericin B source is *Streptomyces nodosus*
- Antimalarial, Quinine source is Cinchona Bark
- Anti-cancerdrugs, Vinblastine, Vincristine source is Vinca Alkaloids.
- Anticancer drugs from natural source – doxorubicin, topotecan, etoposide, bleomycin, paclitaxel.
- Antimalarial drugs from natural source –artemisinin, artemether, amodiaquine, artemether.
- Anti-HIV Drugs from natural source – Curcumin, phenoxidiol, calanolide A.
- Antidiabetic Drugs from natural source – Metformin, harunganin, cryptolepine(Majaz and Khurshid, 2016, Moshi, 2006, Russo *et.al.,* 2010)

About 8000 herbal species are used as ethnomedicines and 25000 therapeutically effective formulations are documented in India (Shaheen *et al.,* 2019). In India, 1.5 million Vaidyas (Traditional Indian Drugs Medicines Using Practitioner) are there. There are around 7800 indian traditional drugs manufacturers.. These manufacturing units consume around 2000 tonnes of Traditional Indian herbs annually (Majaz and Khurshid, 2016, Kokate *et.al.,* 2014).

WHO, officially accepts and recognized the herbal medicines and vaidyas (Traditional health practitioners). It passed various policy matters regarding herbal medicines (Agarwal *et.al.* 2012) By 1991, WHO finalized the guidelines in 6th International Conference of Drug Regulatory Authorities, held at Ottawa. It gave the guidelines for extraction, efficacy, preclinical and clinical toxicological studies, stability and quality assessment and analysis of herbal drugs.(Hasan *et. al.*, 2009)

11.5 Traditional Indian Herbal Medicines - The Safe, Free From Side Effect Medicines

Since conventional Allopathic medicines are having lot of side effects and various research works and clinical use of Herbal Products are proved to be safe and effective medicine with freedom from side effects, so the herbal products are emerged as people's medicines, freely available, and free from side effects.

11.5.1 Limitations of Traditional Indian Herbal Products:

Still there are certain limitations of Herbal Medicines:

- Although Indian Government has come out with a separate Pharmacopeia in which various standardization, testing methods for quality herbal product are listed, but still many herbal plant drugs are not listed and work is going on for these plants. This all is possible due to hardworking of AYUSH Department of Government of India, which constantly promotes and financially supports Indian Medicine System and Indian Herbal products. Due to this people start respecting Herbal Products and their faith in Herbal Products are restored.
- But there is a long way to go and come out with various Research and Developmental Programmes in Herbal Products.

But before proceeding further, let us know limitations of existing Herbal products. They are as under:

- The medicinal use of drug became doubtful in certain cases / Patients.
- There is no fool-proof standard method of preparation of herbal medicines.
- Herbal Products active constituents vary from one geographical source to other geographical source.
- The formulae of Herbal Products are not shared by Vaidyas. They tried to keep the formula with them only and try to pass in his family only. But sometimes, untimely death or non-availability of son / family member at the time of death, they are not able to pass on the secret formula of herbal medicine. So, the formula of Herbal Medicines goes with them or lost forever.

- Any Herbal product is produced form one part of plant. That part simply does not contain one active ingredient only. A number of other chemicals are also present in that part of plant. This creates confusion in the pharmacological results of end product.
- If a plant is dried in shade or under sunlight, the active ingredients vary. So, result of herbal product will also vary.

So, at present we do have vast knowledge of herbal products, but still there is large scope of Research and Drug Discovery and Development of Indian Herbal Medicines.

11.5.2 Future Scope of Traditional Indian Herbal Products

The Traditional Indian Drugs Discovery and Development have tremendous scope in Today's Era.

This is due to following reasons:

- Unavailability of newer Allopathic drugs for newer diseases and existing diseases and disorders. There are many diseases like Corona, AIDS, Cancer, Tuberculosis, etc. where the Allopathic drugs have limited scope.
- There are other diseases and disorders which require continuous drug intake of Allopathic drugs, throughout life. They do not cure the disease or disorder. The various diseases are painful Joints, Arthritis, Asthma, Thyroid, Heart Related Diseases, Blood Pressure Related Problems, Diabetes, Alopecia, Height Increase etc.
- The available Allopathic Drugs produce serious side effects like acidity, ulcer, immunity weakening, constipation, diarrhea, increase or decrease in blood pressure etc.
- Previously old methods of research are there, which are time consuming, but at present, advanced technology is available at our end, like latest sophisticated analytical equipment's, instruments like UV (Ultraviolet – visible spectroscopy), IR (infra-red spectroscopy), FTIR (Fourier Transform Infrared Spectroscopy), HPLC (High performance Liquid Chromatography), NMR (Nuclear Magnetic Resonance Spectroscopy), Mass Spectroscopy etc. These newer technologies like Computer Aided Drug Design (CADD) System, Artificial Intelligence and Robotics are also there (Salim *et. al.,* 2008).
- The Department of AYUSH, CSIR and ICMR have come jointly and give their full support, not only technology wise but also financial projects for the validation of Indian traditional drugs

and for future research work on Indian Traditional Drugs. (Bhutani and Gohil, 2010)

- WHO projects that by 2050, the market of herbal products will grow to 5Trillion Dollars. (Bhattacharya *et.al.*, 2014).

11.5.3 Challenges of Traditional Indian Herbal Products

It is easy to say but in India alone, there are millions of Indian plants, but detailed descriptions of only Few thousands (1500 herbs) are there (Majaz and Khurshid, 2016). If the research work on new drug is to be considered, it took time of more than 10 years, millions of rupees and normally we get only one successful, effective drug after testing 5000 lead compounds, (Balunas and Kinghorn, 2005).

11.6 Conclusion

So, the Researchers can do Drug Discovery and Development in above fields using Traditional Indian Herbal Medicines. They can use ancient literature available to shortlist the Indian Medical Plants and do scientific analytical methods to analyze, standardize and can develop a newer Formulation, which is free from side-effects, more patient friendly with better bioavailability.

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12

A Comparative Study of Traditional & Modern Herbal Formulations: Integrating India's Knowledge System from Past to Future

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12.1 Introduction

India has a profound and ancient tradition of herbal medicine rooted in systems like Ayurveda, Siddha, and Unani. These indigenous medical practices have been developed over centuries, utilizing the therapeutic potential of plants to prevent and treat various ailments. Ayurveda, one of the oldest healthcare systems in the world, emphasizes a holistic approach to wellness by balancing the mind, body, and spirit. Siddha medicine, originating in South India, and Unani medicine, with roots in Greco-Arabic practices, also contribute significantly to India's rich heritage of herbal formulations.

Traditional herbal formulations often use whole plant materials or their extracts in the form of decoctions, powders, or oils. These formulations are based on empirical knowledge passed down through generations. In recent decades, modern science has recognized the value of these ancient practices, leading to the development of advanced herbal formulations using techniques such as nanotechnology, phytopharmaceuticals, and standardized extracts. Modern formulations aim to improve the bioavailability, stability, and targeted delivery of herbal compounds, enhancing their therapeutic efficacy.

Despite these advancements, a gap remains between traditional wisdom and contemporary scientific approaches. Integrating the strengths of both systems is crucial to preserving India's herbal heritage while advancing future therapeutic innovations. This study aims to explore and compare traditional and modern herbal formulations, highlighting how India's ancient knowledge can be effectively integrated with modern scientific methodologies.

12.2 Indian Knowledge System: An Overview

India's traditional medical knowledge system is deeply rooted in ancient healing practices such as Ayurveda, Siddha, and Unani. These systems, developed over thousands of years, emphasize a holistic approach to health and disease management through the use of natural products. Each system is founded on specific philosophical and therapeutic principles that guide herbal formulation and usage (Karunamoorthi *et al.*, 2012):

- **Ayurveda:** Originating more than 3,000 years ago, Ayurveda focuses on maintaining the balance of three fundamental biological energies known as doshas—Vata, Pitta, and Kapha. Ayurvedic formulations are often prepared through classical processes such as kwatha (decoctions), churna (powders), and taila (medicated oils). The knowledge is documented in ancient texts like the Charaka Samhita and Sushruta Samhita, which describe the preparation and therapeutic use of plant-based medicines (Pan *et al.*, 2014).
- **Siddha:** This system, which emerged in South India, emphasizes the balance of the three humors (Vali, Azhal, and Iyam) and focuses on the use of herbs, metals, and minerals. Siddha medicine uses sophisticated methods of herbal extraction and preparation to increase potency and enhance bioavailability. Classical Siddha texts outline procedures for combining herbs with other natural substances to treat a range of chronic conditions (Sen *et al.*, 2010).
- **Unani:** Introduced to India through Persian and Arab influences, Unani medicine is based on the concept of four humors (blood, phlegm, yellow bile, and black bile). Unani herbal formulations are often prepared in the form of decoctions, syrups, and oils, and are known for their emphasis on restoring humoral balance (Sen *et al.*, 2009).

The Indian knowledge system is distinguished by its empirical approach to herbal medicine, which combines observation, experience, and documentation. This foundational knowledge has paved the way for modern scientific exploration and the development of advanced herbal formulations.

12.3 TRADITIONAL HERBAL FORMULATIONS

Traditional herbal formulations are prepared using simple and natural techniques that retain the holistic essence of the plant material. These formulations are based on the synergistic action of multiple plant components, which enhances their therapeutic efficacy. Common methods of preparation include:

- **Decoctions (Kwatha):** Involves boiling plant materials in water to extract water-soluble bioactive compounds. This method is widely used in Ayurveda to prepare herbal teas and medicinal broths (Patwardhan *et al.,* 2009).
- **Powders (Churna):** Drying and grinding herbs into a fine powder for oral administration. This method is used to ensure easy consumption and prolonged shelf life (Payyappallimana *et al.,* 2010).
- **Oils (Taila):** Infusing herbs in a carrier oil through a slow-heating process to extract fat-soluble constituents. These are used for topical applications and internal consumption.

12.4 Examples of Key Herbs Used in Ancient Formulations

- **Mangifera indica (Mango Leaves):** Traditionally used in Ayurvedic medicine for its anti-inflammatory, antioxidant, and gastroprotective properties.
- **Curcuma longa (Turmeric):** Widely used for its anti-inflammatory, antimicrobial, and antioxidant benefits.
- **Terminalia chebula (Haritaki):** Known for its digestive and detoxifying effects.
- **Withania somnifera (Ashwagandha):** Used as an adaptogen to manage stress and promote vitality.

12.5 Strengths of Traditional Herbal Formulations

- **Holistic Approach:** Treats the body as an interconnected system, focusing on overall wellness rather than symptom management.
- **Natural Ingredients:** Uses whole-plant extracts, preserving the synergistic interaction of bioactive compounds.

- **Cultural Heritage:** Reflects centuries of empirical knowledge and therapeutic success.

12.6 Limitations of Traditional Herbal Formulations

- **Variable Bioavailability:** The absorption of active ingredients may vary due to inconsistent preparation methods.
- **Lack of Standardization:** Variations in plant sources, environmental conditions, and preparation techniques may affect formulation quality.
- **Limited Scientific Validation:** Many traditional formulations lack rigorous clinical validation through modern scientific methods.

12.7 MODERN HERBAL FORMULATIONS

Modern herbal formulations incorporate advanced scientific techniques to enhance the efficacy, safety, and delivery of bioactive compounds. These methods aim to overcome the limitations of traditional formulations while preserving their therapeutic potential. Some key advancements include:

- **Nanotechnology:** Incorporating herbal compounds into nanoparticles improves their bioavailability, stability, and targeted delivery. For example, curcumin nanoparticles enhance solubility and absorption in the gastrointestinal tract (Albert *et al.,* 2015).
- **Phytopharmaceuticals:** Standardized plant-derived compounds that undergo rigorous quality control to ensure consistency in dosage and therapeutic effect. This approach helps integrate herbal medicine into mainstream healthcare.
- **Microspheres:** Encapsulating herbal extracts in biodegradable microspheres allows for sustained release, improving therapeutic outcomes and reducing dosing frequency (Sharma *et al.,* 2013).

12.7.1 Examples of Modern Herbal Formulations

- **Mangifera indica Microspheres:** Used to deliver gastroprotective effects in a controlled-release manner, enhancing efficacy against gastric ulcers.
- **Curcumin Nanoparticles:** Increases curcumin's solubility and systemic absorption, improving its anti-inflammatory and anticancer effects.

- **Polyherbal Capsules:** Combining multiple herbal extracts in standardized capsules ensures consistent dosage and synergistic therapeutic action.

12.7.2 Strengths of Modern Herbal Formulations

- **Improved Stability:** Advanced techniques protect bioactive compounds from degradation, extending shelf life.
- **Targeted Delivery:** Nanocarriers enable precise delivery to affected tissues, enhancing therapeutic efficacy.
- **Enhanced Bioavailability:** Innovative preparation methods increase the absorption of poorly soluble herbal compounds.

12.7.3 Limitations of Modern Herbal Formulations

- **Complexity:** Modern formulation techniques require specialized equipment and expertise, increasing production complexity.
- **Higher Cost:** Advanced processing and quality control increase the cost of modern herbal formulations.
- **Potential Loss of Synergy:** Isolating specific active compounds may overlook the synergistic effects of whole-plant formulations.

In summary, traditional and modern herbal formulations offer complementary benefits and challenges. Traditional formulations provide holistic, time-tested remedies rooted in cultural heritage, while modern advancements improve consistency, efficacy, and delivery. This comparative understanding helps integrate India's ancient knowledge system with contemporary scientific innovation, paving the way for future therapeutic advancements (Zhao *et al.,* 2013).

12.8 Comparative Analysis And Discussion

12.8.1 Formulation Techniques

The formulation techniques for herbal medicines have evolved significantly from traditional methods to advanced modern delivery systems. Traditional herbal formulations typically rely on simple and natural preparation processes, while modern approaches incorporate advanced technologies to enhance efficacy and patient compliance.

- **Traditional Methods:** These methods involve basic preparation techniques such as decoctions (boiling plant materials), powders (grinding dried herbs), and medicated oils. These techniques preserve the holistic integrity of herbs, allowing multiple bioactive compounds to work synergistically. However, they often suffer from limitations such as poor solubility, inconsistent dosage, and reduced bioavailability (Dori *et al.*, 2020).

- **Modern Delivery Systems:** Recent advancements in herbal medicine include the use of sophisticated delivery mechanisms like nanoparticles, liposomes, and microspheres. For example, encapsulating herbal extracts in liposomes or nanoparticles can improve the stability of bioactive compounds, enhance targeted delivery, and increase therapeutic efficacy. Mangifera indica microspheres, for instance, provide a controlled release mechanism that ensures prolonged therapeutic action in treating gastric ulcers (Petitet *et al.*, 2012).

Table 1: Comparison of Formulation Techniques

Feature	**Traditional Methods**	**Modern Delivery Systems**
Preparation Techniques	Decoctions, powders, oils	Nanoparticles, liposomes, microspheres
Bioavailability	Low due to poor solubility	High with enhanced absorption
Complexity	Simple and natural	Complex and technology-driven
Stability	Limited shelf-life	Improved stability and controlled release
Cost	Low	Higher due to advanced technology

Therapeutic Efficacy

The therapeutic efficacy of herbal formulations depends on the method of preparation and the bioavailability of active ingredients. Existing literature provides evidence supporting the benefits of both traditional and modern approaches, while also highlighting certain limitations.

- **Traditional Formulations:** Historical and clinical evidence suggests that traditional herbal formulations are effective in managing chronic conditions, promoting overall wellness, and addressing multifaceted health issues. For instance, Mangifera indica has been traditionally used for its gastroprotective and anti-inflammatory properties. However, the lack of standardization in preparation methods may result in variability in therapeutic outcomes.
- **Modern Formulations:** Scientific research supports the enhanced efficacy of modern herbal delivery systems due

to improved absorption and targeted delivery. For example, curcumin nanoparticles exhibit superior anti-inflammatory and antioxidant properties compared to traditional turmeric preparations. The controlled-release characteristics of microspheres ensure sustained therapeutic action, improving clinical outcomes (Sahoo *et al.,* 2010).

Table 2: Therapeutic Efficacy of Herbal Formulations

Parameter	Traditional Formulations	Modern Formulations
Efficacy Consistency	Variable due to lack of standardization	High due to controlled delivery
Onset of Action	Slow	Faster with targeted delivery
Therapeutic Outcomes	Holistic and multi-targeted	Specific and potent
Example	Mangifera indica decoction	Mangifera indica microspheres

12.8.3 Safety and Bioavailability

Safety and bioavailability are critical factors when comparing traditional and modern herbal formulations. Bioavailability refers to the extent and rate at which the active ingredients reach systemic circulation, while safety addresses potential toxicity and long-term health impacts.

- **Safety of Traditional Formulations:** Traditional herbal remedies, derived from whole-plant sources, are generally considered safe due to centuries of empirical use. However, concerns arise from batch-to-batch variability, contamination risks, and inconsistent quality control. For example, some Ayurvedic formulations containing heavy metals pose potential toxicity risks if not properly prepared.
- **Safety of Modern Formulations:** Modern techniques enhance safety through rigorous quality control and standardization processes. Advanced delivery systems like nanoparticles may reduce systemic toxicity by enabling targeted delivery. However, there are concerns about the long-term safety of novel carriers, such as the accumulation of nanoparticles in tissues over time.
- **Bioavailability in Traditional Formulations:** Traditional methods often exhibit lower bioavailability due to the poor solubility of plant compounds. For example, curcumin from turmeric has low water solubility, limiting its absorption in the gastrointestinal tract.

- **Bioavailability in Modern Formulations:** Modern technologies address these challenges by enhancing solubility and absorption. Nanoparticles and liposomes protect bioactive compounds from degradation and facilitate their absorption, resulting in improved therapeutic efficacy. Mangifera indica microspheres, for instance, offer controlled release for better absorption and prolonged activity (Muyumba *et al.,* 2021).

Table 3: Safety and +Bioavailability Comparison

Parameter	**Traditional Formulations**	**Modern Formulations**
Safety Profile	Generally safe with empirical evidence	Enhanced by quality control but uncertain long-term effects
Toxicity Risk	Possible contamination or heavy metals	Potential nanoparticle accumulation
Bioavailability	Limited due to poor solubility	Improved through advanced carriers
Example	Turmeric decoction	Curcumin nanoparticles

12.8.4 Integration of Ancient and Modern Approaches

Integrating ancient knowledge with modern scientific advancements offers a promising pathway for future drug development. By combining the empirical wisdom of traditional herbal medicine with cutting-edge formulation technologies, it is possible to create more effective, safer, and standardized herbal therapies.

- **Validation of Ancient Formulations:** Modern analytical techniques, including high-performance liquid chromatography (HPLC) and mass spectrometry, are used to identify and quantify active compounds in traditional formulations. This scientific validation enhances credibility and facilitates the integration of ancient remedies into evidence-based medicine.
- **Refinement of Formulations:** Modern science refines traditional formulations by isolating bioactive compounds and optimizing delivery systems. For instance, curcumin nanoparticles provide a more bioavailable form of turmeric, enhancing its therapeutic potential without losing its traditional value.
- **Synergistic Opportunities:** There is a significant opportunity to develop hybrid formulations that leverage both traditional and modern strengths. For example, combining whole-plant extracts with advanced delivery systems may preserve the synergistic effects while improving bioavailability and targeted delivery (George *et al.,* 2011).

- **Future Directions:** Collaborative efforts between Ayurvedic practitioners and modern scientists can further advance herbal drug development. Government initiatives, such as those by AYUSH in India, play a pivotal role in promoting integrative medicine and supporting the scientific exploration of ancient remedies.

Table 4: Integration of Ancient and Modern Approaches

Aspect	Traditional Knowledge	Modern Science
Validation Methods	Empirical evidence	Analytical techniques (e.g., HPLC)
Formulation Refinement	Whole-plant extracts	Isolated compounds with delivery systems
Synergistic Potential	Holistic, multi-component approach	Precision and targeted delivery
Future Prospects	Preservation of ancient wisdom	Innovative, evidence-based therapies

Comparison: Integrating ancient and modern approaches creates a comprehensive framework for advancing herbal medicine. While modern techniques improve efficacy and safety, preserving the holistic philosophy of traditional medicine ensures patient-centered care. The future lies in collaborative innovation, where the best aspects of both systems are combined for global health benefit.

12.9 Bridging India's Past And Future

12.9.1 The Role of Indian Knowledge in Modern Drug Discovery

Indian traditional medicine systems, such as Ayurveda, Siddha, and Unani, have significantly influenced modern pharmacology. Bioactive compounds first identified in ancient texts have laid the foundation for several contemporary drugs and therapeutic innovations. The holistic approach of these traditional systems emphasizes personalized treatment, which aligns with modern trends in precision medicine (Boullata *et al.*, 2024).

Table 5: Examples include

Traditional Herb	Historical Use	Modern Application
Mangifera indica	Digestive disorders, anti-ulcer properties	Microsphere-based delivery for gastric ulcers
Curcuma longa	Anti-inflammatory, wound healing	Curcumin nanoparticles for improved absorption

Traditional Herb	Historical Use	Modern Application
Withania somnifera	Stress relief, immune modulation	Adaptogenic supplements for stress management
Emblica officinalis	Rejuvenation, digestive health	Antioxidant-rich formulations for longevity

12.9.2 Policy and Standardization

Government organizations and regulatory frameworks play a vital role in ensuring the safety, efficacy, and standardization of herbal medicines (table: 6). Institutions like AYUSH and the World Health Organization (WHO) provide guidelines for integrating traditional and modern practices. Standardization ensures the reproducibility of herbal medicines and enhances consumer trust while facilitating global market access (Ernst *et al.*, 2007).

Table 6: Policy and Standardization

Regulatory Framework	Role	Impact on Herbal Medicine
AYUSH (India)	Supports research, standardization, and integration	Facilitates scientific validation of traditional knowledge
WHO Guidelines	Provides global standards for herbal medicine safety	Ensures international safety and quality standards
USFDA (USA)	Regulates botanical drugs under pharmaceutical frameworks	Promotes herbal medicines as legitimate therapeutic options
ICMR (India)	Conducts clinical research on traditional formulations	Strengthens scientific credibility of herbal therapies
Pharmacopoeia Commission	Publishes quality standards for Ayurvedic medicines	Ensures product consistency and therapeutic effectiveness

12.9.3 Future Directions: Bridging Tradition and Innovation in Herbal Medicine

The future of herbal medicine lies in integrating traditional knowledge with modern scientific advancements. Collaboration between traditional healers, modern scientists, and pharmaceutical industries is essential to validate herbal formulations and understand their mechanisms of action (Mardani *et al.*, 2013). Interdisciplinary research can identify bioactive compounds while preserving the holistic nature of traditional remedies. Standardization is equally important—comprehensive guidelines and advanced analytical techniques like HPLC and mass spectrometry (Karimi *et al.,* 2015) can ensure the consistent preparation, characterization, and quality control of herbal products.

Innovation through advanced delivery systems, such as nanocarriers and phytopharmaceuticals, offers improved bioavailability and targeted delivery. AI and data analytics can further analyze traditional knowledge to discover novel therapeutic agents, while government and industry partnerships should support the development of new herbal-based therapeutics (Ekor *et al.,* 2014). Table 7 outlines key innovation strategies and their objectives in advancing herbal medicine.

Table 7: Future Directions in Herbal Medicine Innovation

Innovation Strategy	**Objective**
Nanocarriers (e.g., nanoparticles)	Enhance bioavailability and targeted delivery
Phytopharmaceuticals	Integrate herbal bioactives into pharmaceutical forms
Digital Herb Libraries	Preserve and document indigenous knowledge
AI and Data Analytics	Analyze vast traditional knowledge for novel discoveries

Cultural preservation is also crucial—establishing digital repositories and intellectual property frameworks will protect and document India's vast herbal knowledge base (Jagan *et al.,* 2008). Public awareness programs can further safeguard traditional practices by promoting education and cultural heritage. Global collaboration plays a vital role in expanding the reach of Indian herbal formulations. Engaging with international regulatory bodies like the WHO can facilitate the acceptance of Ayurvedic and other traditional practices in global healthcare. By combining ancient wisdom with modern innovation, India's herbal legacy can contribute to enhanced global healthcare outcomes while preserving its cultural identity.

12.10 Conclusion

This chapter has explored the intricate relationship between traditional and modern herbal formulations, highlighting how ancient Indian knowledge has laid the foundation for contemporary pharmacological innovations. Through a comprehensive comparative analysis, several key findings have emerged. Traditional formulation techniques emphasize simplicity and natural preparation methods, while modern approaches leverage advanced technologies like nanoparticles to enhance efficacy and provide controlled drug delivery. This technological advancement improves the precision of treatment while maintaining the therapeutic essence of herbal medicine. In terms of therapeutic efficacy, modern formulations often exhibit superior bioavailability and targeted delivery. However, traditional formulations continue to offer a holistic, multi-targeted therapeutic approach, aligning closely with the principles of personalized and integrative medicine. Safety and standardization also represent a significant point of divergence between traditional and modern practices. Modern regulatory frameworks have addressed many of the safety concerns associated with herbal preparations by ensuring consistency, quality control, and reproducibility. These regulatory advancements mitigate the variability often found in traditional methods, fostering greater trust and acceptance in contemporary healthcare systems. This chapter also underscores the study's contribution to the Indian Knowledge System in several ways. Documenting and analyzing ancient herbal practices plays a vital role in preserving this wealth of traditional wisdom, ensuring its continuity and relevance in modern contexts. Furthermore, by comparing traditional methods with modern scientific advancements, the study reinforces the credibility of age-old practices through scientific validation. This alignment between traditional wisdom and modern science also supports policy advocacy, strengthening the role of regulatory bodies such as AYUSH in shaping future policies that promote the integration of herbal medicine into mainstream healthcare.

In conclusion, this chapter emphasizes the transformative potential of combining India's ancient herbal wisdom with contemporary scientific approaches. Such integration not only enhances therapeutic outcomes but also preserves cultural heritage while advancing global healthcare solutions. By merging the holistic, patient-centered nature of traditional formulations with the precision and efficacy of modern techniques, future innovations in herbal medicine can achieve greater effectiveness and accessibility. Policy support and ongoing research will be essential in fostering this synergy, ensuring that India's rich herbal legacy continues to contribute meaningfully to global health while maintaining its cultural identity. This chapter reaffirms that the future of herbal medicine lies in the harmonious blending of tradition and innovation, offering new possibilities for patient care and scientific discovery.

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Medicinal Plants in Drug Discovery: Bridging Traditional Knowledge and Modern Science

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13.1 Introduction

Plants have served as sources of medications for the treatment of complex ailments since ancient times. They possess the ability of producing several naturally occurring compounds with diverse chemical compositions (Atanasov *et al.,* 2021). Despite significant advancements, a substantial population continues to depend on herbal remedies. Consequently, a comprehensive initiative is necessary to conserve herbal hotspots and scientifically document plant active constituents. Current challenges to the utilization of natural products and the acceptance of their efficacy in therapeutics include: (1) absence of standardization protocols, (2) failure to isolate pure chemical entities, (3) insufficient elucidation of biological mechanisms, and (4) infrequent execution of controlled and documented clinical trials adhering to established standards (Aware *et al.,* 2022, Thomford *et al.,* 2018). Historically, scientific data supports the pharmacological potential of plant-based substances, which contributed to the creation of several breakthrough traditional drugs (Li, 2014, David *et al.,* 2015). The expedition for novel therapeutic candidates derived from natural materials is sometimes hindered by the complexity of molecular combinations (Lahlou, 2013). The therapeutic effectiveness of plant extracts frequently results from the synergistic and simultaneous effect of various compounds. Considering the complicated nature of several ailments, such as cancer and degenerative disorders, it is unsurprising that dependence on single compound-based medication development has proven inadequate in yielding effective therapies. Consequently, plant-based drug development should start with a combinatorial strategy for assessing candidate molecules (Cao *et al.,* 2024, Prabhakar *et al.,* 2014, Sauter, 2020).

13.2 The Transition from Traditional Medicine to Modern Drug Discovery

A paradigm shift took place from traditional herbal remedies to modern drug development and therapy,driven by advancements in the fields of structural biology, proteomics, genomics, molecular biochemistry, biological sciences, systems biology, and computer science (Thomford *et al.,* 2018). Rational drug development methodologies enable the modelling of targets, the design of diverse analogues, and their docking with the target, followed by screening, analysis, and prediction of pharmacokinetic and pharmacodynamic features (Kashyap *et al.,* 2025, Bisht *et al.*). Rational methodologies have markedly decreased the expenses, labour, and likelihood of failure in drug discovery processes (Lahlou, 2007). Recent technical and scientific advancements, including Advanced methods for analysis, genome mining techniques and engineering approaches, together with progress in microbiological culture, are addressing these challenges and generating new opportunities. Consequently, demand for natural products as prospective therapeutic possibilities is being revitalized, especially in addressing antimicrobial resistance (Hobson *et al.,* 2021). This review summarizes current technology advancements facilitating natural product-based drug discovery, highlights specific applications, and discusses significant potential.

13.3 Methods of Drug Discovery

13.3.1 Traditional Methods (Ethnobotanical Surveys)

Ethnopharmacology has established an initial foundation for the medicinal application of natural substances by elucidating the medicinal properties of plants. Natural products, whether in their original state or following the crude extraction of active compounds, have historically been utilized by many communities and investigated as essential resources for medication development. Ethnobotany studies the relationship between cultures and plants (Nolan and Turner, 2011). Humans have possessed distinct pharmacological knowledge regarding the medicinal effects of plants from the onset of their journey through evolution, which is reflected in ancient and subsequent cultural legacy (Halberstein, 2005). Nonetheless, this expertise, amassed in conventional medicine and the ethnopharmacology, is diminishing. Many existing pharmaceuticals are derived from natural products, with notable examples including taxol, vinblastine, quinine, and artemisinin, which originate from traditional medicine and ethnopharmacology; however, these substances have subsequently been synthesized through contemporary chemistry and reassessed using modern analytical and pharmacological techniques (Gurib-Fakim, 2006, Chaachouay and Zidane, 2024). Figure 1 illustrates the process of drug discovery and development by the traditional method.

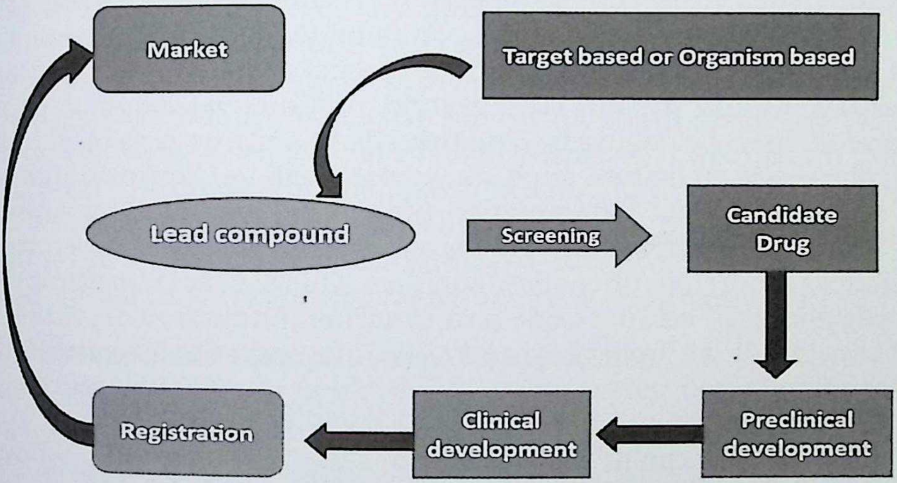

Fig. 1: Traditional Method of Drug Development

13.3.2 Modern Methods

Contemporary or modern drug development includes the identification of screening hits, pharmaceutical chemistry, and the optimization of these hits to enhance affinity, selectivity (to mitigate potential adverse effects), effectiveness/potency, metabolic stability (to extend half-life), and oral bioavailability (Cox and Gupta, 2022, Zhan *et al.,* 2022). The methods involved are phytochemical screening, high-throughput screening, bioinformatics, and computational approaches, metabolomics. Upon identifying a molecule that meets all specified criteria, the drug development process will commence before clinical trials.

Phytochemical Screening

Phytochemicals have a longstanding and successful legacy in pharmacological development. Phytochemical screening involves extracting and analyzing bioactive compounds from plants to identify potential therapeutic agents. This targeted approach accelerates the discovery of specific bioactive compounds (Altemimi *et al.*, 2017). Recent progresses in analytical methods and methodology have facilitated the discovery of bioactive leads from natural chemicals (Harborne, 1998). Numerous natural compounds derived from plants are being utilized to address various ailments, including diarrhea, a significant global health concern. Apart from this, the extracts from herbal drugs function as antisecretory agents, have antiperistalsis actions, and possess antibacterial and antispasmodic characteristics (Garrido *et al.*, 2024, Chihomvu *et al.*, 2024). Apigenin and friedelin have been recognized as antidiarrheal agents due to their antisecretory and antimotility characteristics (Afreen and Ahirwar, 2023, Chihomvu *et al.*, 2024). Panax ginseng includes various natural compounds, including ginsenosides, that boost immunity, reduce inflammation, and fight cancer (Riaz *et al.*, 2019, Kim *et al.*, 2017). Turmeric, or *Curcuma longa*, a popular Ayurvedic herb belonging to Zingiberaceae family, is rich in curcumin and possesses activities such as wound-healing, anti-oxidants, and the property against inflammation (Kant *et al.*, 2014, Chuysinuan *et al.*, 2023). North American *Echinacea* also treats respiratory issues. Echinacea contains phenolics such as chicoric acid, caftaric acid, chlorogenic acid, echinacoside and cynarine (Ahmadi *et al.*, 2024, Lim and Lim, 2014). Antimicrobial and antioxidant volatile terpenes include germacrene D and polyacetylene (Widelski *et al.*, 2021). Ascorbic acid boosts immunity (Van Hieu *et al.*, 2022). Arabinogalactans, inulin, and heteroxylans, plant polysaccharides and glycoproteins, stimulate and reduce inflammation during disease (Meeran *et al.*, 2021). *Allium sativum, Melaleuca alternifolia*, and *Melissa officinalis* essential oils cure infections of the respiratory, gastrointestinal, urinary, and integumentary systems (Caballero-Gallardo *et al.*, 2025, Rani *et al.*, 2023). Using modern technology, phytochemicals can be used in drug discovery. Optimizing high-throughput screening and computational methods help speed up phytochemical therapies. Emerging technology and transdisciplinary research will maximize phytochemicals' disease-treating potential (Ismail *et al.*, 2024). These cutting-edge techniques can uncover new novel treatments with global patient consequences.

High-Throughput Screening (HTS)

HTS is an essential tool in contemporary drug development that enables researchers to rapidly and effectively evaluate hundreds to millions of chemicals evaluated for their biological efficacy against a certain target (Aldewachi *et al.,* 2021, Ayon, 2023). It has emerged as a fundamental component of contemporary drug development, facilitating the fast and effective identification of prospective therapeutic candidates from extensive chemical libraries. HTS expedites the first phases of drug development by integrating automation, precise detection techniques, and extensive screening capabilities, therefore substantially decreasing time and expenses (Joshi and Makwana, 2025). Its capacity to assess a diverse array of biological targets, from enzymes to whole cells, has broadened the horizons of drug development, facilitating the identification of innovative therapeutic agents for many illnesses, particularly those with unaddressed medical requirements. HTS has facilitated lead identification and optimization while enabling the creation of personalized and targeted medicines, notably through its interaction with omics technologies (Prajapati *et al.,* 2024, Molla and Bitew, 2024). Notwithstanding constraints such as data complexity and the risk of false positives or negatives, progress in data analysis and assay design is consistently enhancing the accuracy and dependability of high-throughput screening (Wätzig *et al.,* 2015). With technological advancements, HTS will remain pivotal in the future of medicinal chemistry, promoting the creation of more effective, selective, and safe medicines. HTS also has the potential to transform drug discovery, facilitating the advancement of more novel and personalized therapies for many ailments (Lightbody *et al.,* 2019).

Bioinformatics and Computational Approaches

Bioinformatic methodologies are currently indispensable for high-throughput data analysis in therapeutic target discovery, mechanism-driven development of drugs, drug repurposing, and adverse effect prediction (Zhang *et al.,* 2025, Xia, 2017). Extensive datasets derived from "omics" methodologies necessitate bioinformatic analyses to elucidate relationships and patterns in disease-related circumstances (Ogunjobi *et al.,* 2024). These technologies facilitate database annotations, pattern recognition, link identification, molecular association analysis, and data visualization (Miryala *et al.,* 2018). Recently, significant technical advancements in fields such as the structural characterization of biomacromolecules, computer sciences, and molecular biology have made it possible to design drugs reasonably (Altman and Dugan, 2003). The computer-Aided Design (CADD) technology is no longer only a promising method. Supporting the medicinal chemist in this manner is a method that is both practical and realistic. On its own, it is very improbable that it would result in the development of innovative pharmaceuticals; but it has developed into an important instrument, serving as a guide to synthesis and a help to cognition. A clear molecular reason may be contributed by medications that are synthesized and evaluated using computational approaches. Furthermore, these pharmaceuticals can give a stimulus to the imagination, which is the most important benefit (Young, 2009, Chou, 2004).

Metabolomics

Metabolomics is a powerful technology with extensive uses in pharmacological discovery and advancement of drugs (Idle and Gonzalez, 2007). This process facilitates the detection of modifications in metabolism profiles, producing substantial biomarkers and clarifying the systems that govern illnesses and pharmacological effects (Johnson *et al.*, 2016). The forthcoming integration of metabolomics with technologies like gene editing, cell sorting, and single-cell analysis is expected to elucidate gene–metabolite networks, fundamental biological processes, and disease mechanisms (Danzi *et al.*, 2023, Rana *et al.*, 2024). This convergence will provide new opportunities for identifying drug targets and improving the understanding of drug mechanisms of action. The amalgamation of metabolomics data with other omics fields, including genomes, transcriptomics, proteomics, and microbiomics, will augment our comprehension of health and illness, as well as our ability to identify and formulate innovative therapies (Ogunjobi *et al.*, 2024). Despite current obstacles in data utilization, metabolomics-derived biomarkers possess considerable potential for disease risk assessment and precision medicine, enabling the selection and personalization of medical therapies according to an individual's metabolic profile. This biomarker-driven methodology in pharmacological development facilitates the expedited approval of novel treatments and improves risk assessment throughout various stages of the development process (Vo and Trinh, 2024, Jacob *et al.*, 2019). Moreover, metabolomics is expected to play a growing role in offering a functional assessment of genetic diversity, encompassing both prevalent and uncommon mutations identified through genomic methods in extensive population studies (Lagoumintzis and Patrinos, 2023). Incorporating metabolites as longitudinal and phenotypic metrics with individual genome sequences enables metabolomics to improve precision medicine, replacing current symptom-based approaches and single-disease preventative efforts (Kennedy *et al.*, 2018). Figure 2 elucidates the modern drug development methods, which offer a comprehensive, efficient path in drug discovery.

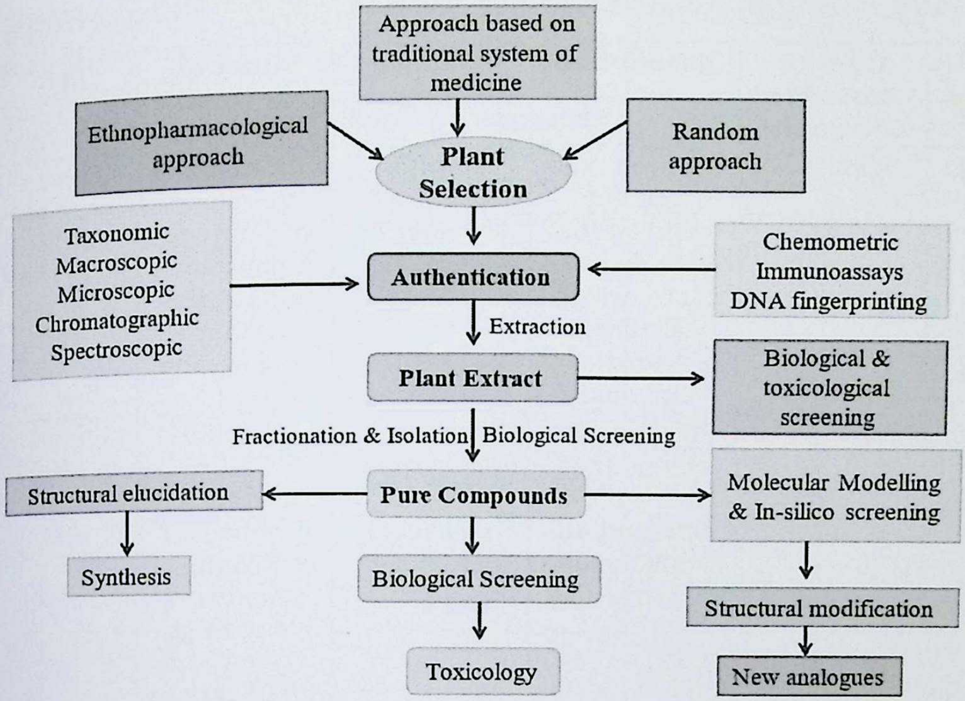
Approach based on traditional system of medicine
Ethnopharmacological approach
Plant Selection
Random approach
Taxonomic
Macroscopic
Microscopic
Chromatographic
Spectroscopic
Authentication
Chemometric
Immunoassays
DNA fingerprinting
Extraction
Plant Extract
Biological & toxicological screening
Fractionation & Isolation
Biological Screening
Structural elucidation
Pure Compounds
Molecular Modelling & In-silico screening
Synthesis
Biological Screening
Structural modification
Toxicology
New analogues

Fig. 2: Integrating Traditional Knowledge with Modern Techniques

13.4 Key Bioactive Components in Medicinal Plants

The extensive biodiversity of medicinal plants presents a diverse range of chemical constituents with potential health benefits. Alkaloids, flavonoids, terpenoids, phenolics, and essential oils represent several bioactive compounds present in these plants. The therapeutic effects of these substances, encompassing antibacterial, antioxidant, anti-inflammatory, anticancer, and immunomodulatory activity, have been extensively studied (Dillard and German, 2000, Koche *et al.*, 2016). In addition to their robust therapeutic benefits, medicinally active components derived from medicinal plants are favored for their natural origin, which is perceived as safer and more ecologically sustainable than manufactured pharmaceuticals (Thakur *et al.*, 2020). Furthermore, traditional practices and knowledge of medicinal plants have significantly contributed to the identification of novel bioactive chemicals, establishing a robust foundation for contemporary medication development. Different classes of bioactive compounds obtained from medicinal plants exhibiting diverse chemical structures and therapeutic potential are given in Table 1.

Table 1: Description of Bioactive Components Derived from Medicinal Plants

S. No.	Class of Bioactive Compound	Description	Example and Source	Structure	Ref.
1.	Alkaloids	Nitrogen-containing compounds with diverse pharmacological effects, often toxic in high doses	Morphine (*Papaver somniferum* - Opium poppy)	Complex ring structure with nitrogen atoms; contains a phenanthrene ring system	(Labanca *et al.*, 2018)
2.	Flavonoids	Polyphenolic compounds with antioxidant and anti-inflammatory properties	Quercetin (*Allium cepa* - Onion, *Ginkgo biloba*)	Basic C6-C3-C6 framework; a flavone core consisting of two benzene rings linked by a three-carbon bridge	(Kothari *et al.*, 2020)
3.	Terpenoids	Largest class of plant-derived compounds, often with anti-inflammatory and antimicrobial effects	Artemisinin (*Artemisia annua* - Sweet Wormwood)	Contains multiple isoprene (C5H8) units; sesquiterpene lactone structure in artemisinin	(Das, 2012)
4.	Saponins	Glycosides with foaming characteristics, commonly having immune-modulatory effects	Diosgenin (*Dioscorea villosa* - Wild yam)	Aglycone steroid core; glycosidic linkage attached to sugar residues	(Ulbricht *et al.*, 2003)
5.	Phenolic Acids	Simple phenolic compounds with anti-inflammatory and antioxidant properties	Salicylic Acid (*Salix alba* - Willow bark)	Contains a benzene ring with a hydroxyl and carboxyl group (hydroxybenzoic acid structure)	(Lin *et al.*, 2023)

S. No.	Class of Bioactive Compound	Description	Example and Source	Structure	Ref.
6.	Tannins	Polyphenolic compounds with astringent properties, beneficial in wound healing and antimicrobial activity	Ellagic Acid (*Punica granatum* - Pomegranate)	Contains multiple aromatic rings with hydroxyl groups; ellagitannin structure	(BenSaad *et al.*, 2017)
7.	Coumarins	Aromatic lactones with anticoagulant, anti-inflammatory, and vasodilatory effects	Coumarin (*Dipteryx odorata* - Tonka bean)	Benzopyrone structure with a fused lactone ring; linear and angular forms	(Toma *et al.*, 2025)
8.	Lignans	Polyphenols with antioxidant, anti-inflammatory, and anti-cancer properties	Podophyllotoxin (*Podophyllum peltatum* - Mayapple)	Two phenylpropanoid units connected by a central bond; resembles diphenyl structure	(Singh and Agrawal, 2024)
9.	Glycosides	Compounds with sugars bonded to active moieties, enhancing solubility and bioactivity	Digoxin (*Digitalis purpurea* - Foxglove)	Steroidal core linked to sugar moieties; contains lactone ring	(Zahid and Rizwani, 2016)

13.5 Significant Pharmaceuticals Derived from Plants: Notable Examples

Many groundbreaking pharmaceuticals have their origins in ancient herbal remedies, underscoring the significant influence of medicinal plants on modern medicine. Aspirin, derived from the components of willow bark (Salix spp.), has been employed by various civilizations for ages to alleviate pain and reduce fever (Mahdi, 2010). Willow bark was utilized by the ancient Egyptians, Greeks, and Native Americans for its therapeutic benefits. In the 19th century, scientists isolated salicin from the bark, which was then chemically processed to generate acetylsalicylic acid, commonly known as aspirin (Montinari *et al.,* 2019). In 1897, Bayer chemist Felix Hoffmann synthesized this modified chemical, which was identified as gentler on the stomach and very efficient, revolutionizing pain management (Rooney and Campbell, 2017). Aspirin is currently one of the most widely utilized medications globally, serving as an analgesic, anti-inflammatory, antipyretic, and a prophylactic agent against myocardial infarctions and cerebrovascular accidents due to its antiplatelet characteristics (Alegbeleye *et al.,* 2020).

Artemisinin, another significant plant-derived pharmaceutical, was isolated in the 1970s by Chinese researcher Tu Youyou during her pursuit of antimalarial therapies based on Traditional Chinese Medicine (TCM) (Guchait *et al.,* 2023). Ancient texts on the fever-reducing properties of *Artemisia annua*, or sweet wormwood, guided Tu in isolating artemisinin, which had significant efficacy against *Plasmodium falciparum*, the parasite responsible for the most lethal kind of malaria (Tilley *et al.,* 2016). Artemisinin stimulates the generation of reactive oxygen species that are fatal to the parasite, forming the foundation for current artemisinin-based combination treatments (ACTs), a crucial strategy against malaria, particularly in regions exhibiting resistance to other medications (Yan *et al.,* 2015).

Another notable success story is paclitaxel (Taxol), an antineoplastic drugs obtained from the Pacific yew tree (*Taxus brevifolia*). In the 1960s, a comprehensive screening initiative conducted by the U.S. National Cancer Institute revealed paclitaxel's potential anti-cancer efficacy (Goodman and Walsh, 2001). It stabilizes microtubules in neoplastic cells, hence impeding cellular division and ultimately resulting in cellular apoptosis. This action has made it very effective against ovarian, breast, and lung malignancies (Abal *et al.,* 2003, Bergstralh and Ting, 2006). The sluggish development of yew trees in the first stage limited the production of paclitaxel, raising sustainability issues. Scientists have devised synthetic and semi-synthetic manufacturing methods to guarantee that the supply will not deplete natural resources.

These drugs exemplify the transformative role of medicinal plants in drug discovery, from traditional practices to scientific breakthroughs. Each instance highlights the potential for uncovering invaluable therapies in nature, and the necessity for sustainable and creative methods in providing these therapies to patients worldwide is underscored. Table 2 enumerates some recent pharmacological advancements derived from plants, detailing their origins, therapeutic uses, mechanisms of action, and current status.

Table 2: Recent Pharmacological Advancements Derived from Plants

S/N	Drug/Compound	Plant Source	Therapeutic Area	Mechanism of Action	Current Status	Ref.
1.	Galantamine	Snowdrop (*Galanthus nivalis*)	Alzheimer's Disease	Inhibits acetylcholinesterase, increasing acetylcholine in the brain	Approved for Alzheimer's treatment; also synthetically produced for broader access	(Singh *et al.,* 2024)
2.	Combretastatin A-4	African Bush Willow (*Combretum caffrum*)	Cancer (Oncology)	Disrupts tumor blood vessels, leading to tumor cell starvation and death	Passed various clinical trials for resistant cancers like ovarian and thyroid	(Baytas, 2022, Singh, 2024)
3.	Artemisinin	Sweet Wormwood (*Artemisia annua*)	Malaria	Produces reactive oxygen species toxic to *Plasmodium* parasites	Standard component in artemisinin-based combination therapies (ACTs) for malaria	(van der Pluijm *et al.,* 2021)
4.	Paclitaxel (Taxol)	Pacific Yew (*Taxus brevifolia*)	Cancer (Breast, Ovarian, Lung)	Stabilizes microtubules, preventing cancer cell division	Approved for cancer treatment; now semi-synthetically produced for sustainability	(Swamy and Vasamsetti, 2022)
5.	Aspirin	Willow Bark (*Salix spp.*)	Pain, Inflammation, Cardiovascular	Inhibits cyclooxygenase (COX) enzymes, reducing inflammation and blood clotting	Widely used as an analgesic, anti-inflammatory, and antiplatelet agent	(Alegbeleye *et al.,* 2020)

13.6 Challenges In Medicinal Plant Research

The use of bioactive chemicals from medicinal plants for many health applications presents both obstacles and opportunities. Despite the considerable promise attributed to these chemicals, some challenges must be resolved for practical use. The following outlines obstacles and prospective directions in this domain:

13.6.1 Standardization and Quality Control

A significant concern is the standardization and quality control of pharmaceuticals obtained from medicinal plants. Variations can influence the amount and concentration of bioactive compounds in growing circumstances, harvesting methods, and treatment techniques (Srivastava and Misra, 2018). Standardized processes for cultivation, extraction, and preparation must be used to guarantee uniform quality and bioactivity of the product.

13.6.2 Bioavailability and Pharmacokinetics

Bioavailability denotes the proportion of a substance that reaches systemic circulation and exerts the desired effects. Low bioavailability of several bioactive compounds in medicinal plants can be attributed to aspects including inadequate solubility, rapid metabolism, and suboptimal absorption. Addressing these problems necessitates novel tactics, including nanoparticle-based delivery systems, prodrug synthesis, and the use of adjuvants to improve absorption and stability (Anwar *et al.,* 2019, Ma *et al.,* 2024).

13.6.3 Safety and Toxicity

The assessment of safety and toxicity of bioactive chemicals from medicinal plants is essential for their clinical use. Although natural chemicals are often regarded as harmless, they may nonetheless produce harmful consequences, particularly at elevated levels or with extended usage (George, 2011). Thorough toxicological investigations, encompassing both acute and chronic toxicity evaluations, are essential to determine acceptable dose parameters and recognize any interactions or contraindications.

13.6.4 Clinical Evidence and Its Translation

Although in vitro and preclinical studies have illuminated the bioactivities of medicinally active constituents from herbs, more clinical research is necessary to confirm their effectiveness, safety, and appropriate therapeutic uses in people. Stringent clinical trials with suitable research design, enough sample size, and defined goals are crucial for producing substantial evidence for regulatory approvals and clinical practice (Chen *et al.,* 2016, Ebadi and Mohebi, 2024). Table 3 highlights several challenges which hinder the effective utilization of bioactive compounds from medicinal plants, including sustainability issues, standardization difficulties, regulatory hurdles, and the need for scientific validation.

Table 3: Challenges in Utilizing Bioactive Compounds from Medicinal Plants

S/N	Challenge	Description	Ref.
1.	Sustainability	Overharvesting and habitat destruction threaten the species of plants.	(van Wyk and Prinsloo, 2018)
2.	Standardization	Variability in phytochemical content due to growing conditions.	(Jain *et al.*, 2023)
3.	Quality Control	Ensuring purity and potency of plant extracts.	(Zhang *et al.*, 2012)
4.	Bioavailability	Low bioavailability and stability of some phytochemicals.	(Kamble *et al.*, 2018)
5.	Intellectual Property	Issues related to the ownership of traditional knowledge.	(Timmermans, 2003)
6.	Regulatory Hurdles	Complex regulatory requirements for approval.	(Raju and Das, 2024)
7.	Scientific Validation	Need for rigorous scientific validation of traditional uses.	(Mukherjee, 2022)
8.	Economic Factors	High cost and time investment for research and development.	(Dajic-Stevanovic and Pljevljakusic, 2015)
9.	Ethnobotanical Data	Loss of traditional knowledge with the passing of elder generations.	(Scherrer *et al.*, 2023)

13.7 Conclusion

In summary, bioactive chemicals derived from medicinal plants provide significant promise for treating many health issues and enhancing general well-being. Ongoing study, innovation, and cooperation will enhance their therapeutic advantages, establishing the groundwork for the development of personalized, safe medicines derived from natural sources. Medicinal plants have played a crucial role in drug discovery, providing essential compounds like artemisinin and paclitaxel. Their diverse bioactive properties continue to offer immense potential for new therapeutic breakthroughs. Ongoing research and advancements in technology are paving the way for innovative treatments and personalized medicine. The future of medicinal plant research promises exciting discoveries and transformative impacts on healthcare.

13.8 Future Prospects

Creating standardized phytopharmaceutical formulations that integrate several bioactive components from medicinal plants might augment their therapeutic efficacy. Moreover, synergistic interactions between several drugs may enhance effectiveness, bioavailability, and targeted distribution to specific tissues or cells. Pharmacogenomic techniques can identify genetic polymorphisms that influence individual responses to bioactive compounds in medicinal plants. The advancement of personalized medicine approaches enabling tailored medicines based on an individual's genetic makeup can be enhanced by comprehending the interindividual variability in medication metabolism, efficacy, and adverse reactions. Apart from this, collaboration between traditional medicine and contemporary science can encourage the partnership between traditional medicine and modern science, allowing researchers to integrate traditional knowledge with evidence-based methodologies. Integrating the insights of traditional medicine with stringent scientific approaches might improve the advancement and use of medicinally active compounds, constituents obtained from herbal drugs. The effective application of these constituents and their transformation into evidence-based therapies would be enhanced by resolving these challenges and exploring prospective avenues.

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14

Traditional Indian Approaches to Disease Management and their Relevance Today

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14.1 Introduction

India has a rich history of traditional medicine systems that have been practiced for centuries. Ayurveda, Siddha, Unani, and Yoga are some of the key traditional approaches to disease management in India. These systems focus on holistic well-being, emphasizing preventive care, personalized treatment, and the balance of body, mind, and spirit. With the growing interest in integrative medicine, these ancient practices are gaining recognition for their potential contributions to modern healthcare.

Traditional Indian medicine has played a vital role in healthcare for centuries, offering a holistic and natural approach to disease management. Systems such as **Ayurveda, Siddha, Unani, Yoga, and Naturopathy** are deeply rooted in Indian culture and emphasize the balance between body, mind, and spirit. These ancient practices focus on preventing diseases, enhancing overall health, and treating ailments through natural means, including herbal remedies, dietary modifications, detoxification therapies, and mind-body practices. Unlike conventional medicine, which primarily targets symptoms, traditional Indian medicine aims to identify and eliminate the root causes of diseases while promoting long-term well-being.

14.2 Historical Context and Evolution

The origins of traditional Indian medicine can be traced back thousands of years, with early references found in **Vedic texts** such as the *Atharvaveda* and *Charaka Samhita*. Ayurveda, meaning "science of life," is one of the oldest and most widely practiced systems, focusing on balancing the three doshas (Vata, Pitta, and Kapha) to maintain health. Siddha medicine, primarily followed in South India, utilizes a combination of herbal, mineral, and animal-based treatments to address both physical and spiritual ailments. In addition to medicinal practices, Yoga and Naturopathy have significantly contributed to disease prevention and management. Naturopathy promotes healing through **natural elements** such as fasting, hydrotherapy, mud therapy, and a plant-based diet.

14.3 Principles of Traditional Indian Medicine

The fundamental principles of traditional Indian medicine revolve around the **concept of balance, natural healing, and disease prevention**. Some of the key aspects include:

Holistic Approach – Traditional Indian medicine treats the individual as a whole, considering physical, mental, and emotional health rather than just focusing on disease symptoms. Unlike conventional medicine, which primarily focuses on treating disease symptoms, traditional Indian medicine considers the **physical, mental, emotional, and spiritual** aspects of an individual. The holistic approach aims to maintain overall harmony in the body, prevent diseases, and promote longevity through natural healing processes (Sharma and Chandola, 2011).

14.4 Principles of the Holistic Approach in Traditional Indian Medicine

Traditional Indian medicine follows a holistic approach that considers the body, mind, and spirit as interconnected entities essential for overall well-being. Systems such as Ayurveda, Siddha, Unani, and Yoga and Naturopathy emphasize balance, harmony, and disease prevention rather than merely treating symptoms. Ayurveda, based on the Tridosha theory (Vata, Pitta, and Kapha), views health as a dynamic equilibrium between these three bodily energies, requiring proper diet, lifestyle, and mental discipline for maintenance (Sharma and Chandola, 2011). Siddha medicine integrates herbal remedies, yogic practices, and detoxification methods to cleanse the body and enhance longevity (Sujatha and Abraham, 2012).

The Unani system follows the humoral theory, which stresses the balance of four bodily fluids blood, phlegm, yellow bile, and black bileachieved through diet therapy, herbal formulations, and physical regimens such as cupping and massage (Rahman, 2018). Yoga and Naturopathy focus on holistic healing through asanas (postures), pranayama (breathing techniques), meditation, fasting, and natural detoxification therapies to promote physical and mental resilience (Telles *et al.,* 2009).

A key principle across all these systems is personalized medicine, where treatment is tailored to an individual's unique constitution (Prakriti in Ayurveda) and lifestyle. Another fundamental aspect is preventive healthcare, which includes seasonal routines (Ritucharya), daily regimens (Dinacharya), and mental wellness practices to prevent diseases before they manifest (Mukherjee *et al.,* 2017). The modern resurgence of these holistic principles highlights their sustainability, minimal side effects, and effectiveness in managing chronic and lifestyle disorders, making them highly relevant in contemporary healthcare.

14.4.1 Balance of Bodily Energies

Ayurveda, one of the oldest medical systems, is based on the **Tridosha theory**, which states that health is maintained through a balance of **Vata, Pitta, and Kapha**(Rahman, 2018). An deviation in these doshas resultsin diseases, and treatment involves restoring balance through dietary changes, herbal medicine, and lifestyle modifications (Patwardhan *et al.,* 2005).

14.4.2 Integration of Mind and Body

Traditional Indian medicine recognizes the **mind-body connection**, considering mental health as an essential component of physical health. **Yoga and meditation** play a crucial role in managing stress, anxiety, and depression while improving overall well-being (Telles *et al.,* 2009). Research has shown that **meditation and pranayama (breathing techniques)** can lower stress hormones, reduce inflammation, and improve cognitive function (Gupta *et al.,* 2018).

14.4.3 Preventive Healthcare

A major aspect of the holistic approach is **disease prevention** through lifestyle modifications and natural therapies. Ayurveda emphasizes **Dinacharya (daily routine)** and **Ritucharya (seasonal routine)** to maintain health and prevent diseases (Mukherjee *et al.,* 2017). Siddha medicine also incorporates **dietary and lifestyle regulations** to enhance immunity and longevity (Sujatha and Abraham, 2012).

14.4.4 Natural and Herbal Remedies

Traditional Indian medicine primarily relies on **herbs, minerals, and natural products** for treatment, minimizing side effects compared to synthetic drugs. Many modern pharmaceuticals, including **anti-malarial and anti-cancer drugs**, have been derived from traditional Indian medicinal plants (Gurib-Fakim, 2006). Research continues to validate the efficacy of Ayurvedic herbs such as **Ashwagandha (Withania somnifera)** for stress reduction (Patwardhan and Mashelkar, 2009).

14.4.5 Detoxification and Rejuvenation

Ayurvedic therapies like **Panchakarma** focus on detoxifying the body to eliminate toxins and restore balance. Similarly, **Naturopathy** employs hydrotherapy, fasting, and mud therapy to cleanse and rejuvenate the body (WHO, 2019). These detoxification methods help in **enhancing digestion, boosting immunity, and preventing chronic illnesses** (Sharma and Chandola, 2011).

14.5 Relevance of the Holistic Approach in Modern Healthcare

Studies suggest that integrating **Ayurveda, Yoga, and herbal medicine** with modern treatments can enhance therapeutic outcomes (Patwardhan and Mashelkar, 2009).Governments and international organizations, including the **World Health Organization (WHO)**, are actively promoting traditional medicine for **primary healthcare and disease prevention** (WHO, 2019). However, challenges such as **scientific validation, standardization, and regulatory approval** must be addressed to ensure its widespread acceptance in modern medicine (Mukherjee *et al.,* 2017).

14.5.1 Preventive Healthcare

Ayurveda, Yoga, and Siddha emphasize the importance of lifestyle choices, seasonal detoxification, and mental well-being in preventing diseases before they manifest. Preventive healthcare is a fundamental principle of traditional Indian medicine, emphasizing the prevention of diseases rather than just their treatment. Systems such as Ayurveda, Siddha, Unani, and Yoga and Naturopathy focus on maintaining health through balanced diets, seasonal regimens, detoxification, and mental well-being. Ayurveda, for instance, prescribes Dinacharya (daily routine) and Ritucharya (seasonal regimen) to align bodily functions with natural rhythms, thereby preventing lifestyle-related disorders such as diabetes, hypertension, and obesity (Sharma and Chandola, 2011). Regular use of herbal medicines like Turmeric (Curcuma longa) for immunity, Amla (Emblica officinalis) for rejuvenation, and Tulsi (Ocimum sanctum) for respiratory health helps in disease prevention (Mukherjee *et al.,* 2017).

Similarly, Siddha medicine integrates dietary guidelines, yoga, and herbal tonics to enhance longevity and prevent chronic illnesses (Sujatha and Abraham, 2012). Unani medicine emphasizes Ilaj bil Tadbeer (regimen therapy), including cupping, massage, and steam baths, to remove toxins and maintain overall well-being (Rahman, 2018).

Yoga and Naturopathy play a significant role in preventive healthcare by promoting physical fitness, stress reduction, and detoxification. Yoga practices such as pranayama (breathing techniques) and meditation have been shown to enhance immunity, reduce anxiety, and improve cardiovascular health (Telles *et al.,* 2009). Naturopathy encourages fasting, hydrotherapy, and plant-based nutrition, which help in preventing metabolic disorders and boosting the body's natural healing capacity (WHO, 2019).

With the rise of lifestyle diseases and mental health issues, traditional preventive healthcare strategies are gaining global recognition. The holistic, personalized, and sustainable nature of these practices makes them highly relevant in modern integrative medicine, contributing to long-term well-being and disease resistance.

14.5.2 Personalized Treatment

Ayurvedic practitioners assess Prakriti through pulse diagnosis, tongue analysis, and lifestyle evaluation, prescribing specific herbal formulations, dietary plans, detoxification therapies (Panchakarma), and yoga practices to restore equilibrium (Mukherjee *et al.,* 2017). Similarly, Siddha medicine categorizes individuals based on their Mukkutram (Vatham, Pitham, and Kapham) and provides customized treatments using herbs, minerals, and lifestyle modifications (Sujatha and Abraham, 2012).Unlike conventional medicine, which often follows a standardized treatment approach, traditional systems focus on customized interventions to restore balance and promote holistic well-being (Patwardhan *et al.*, 2005).

The Unani system follows a humoral theory, where individuals are classified into hot, cold, moist, and dry temperaments. Treatments involve balancing these temperaments using herbal medicines, diet therapy, and regimental practices like cupping and massage (Rahman, 2018). Yoga and Naturopathy also emphasize personalized health strategies, recommending specific asanas, pranayama (breathing techniques), and natural therapies based on an individual's health condition and physiological responses (Telles *et al.*, 2009).

With the increasing recognition of personalized medicine in modern healthcare, traditional approaches offer valuable insights into individualized treatment strategies. Recent research highlights that genomics and molecular biology can complement Ayurveda's Prakriti-based classification to develop evidence-based, customized treatments (Patwardhan and Mashelkar, 2009). Integrating traditional personalized treatments with modern scientific advancements can enhance efficacy, safety, and patient compliance, making them highly relevant in contemporary healthcare.

14.5.3 Natural and Herbal Remedies

The use of **medicinal plants, minerals, and natural substances** ensures minimal side effects while effectively treating various ailments. Traditional medicine systems such as Ayurveda, Siddha, and Unani have long relied on natural and herbal remedies for disease prevention and treatment. These remedies are derived from medicinal plants, minerals, and natural substances, emphasizing a holistic approach to healing with minimal side effects. Siddha medicine, which integrates herbal and mineral-based formulations, extensively uses Aloe vera, Amla (Emblica officinalis), and Tulsi (Ocimum sanctum) for their rejuvenating and immune-boosting properties (Sujatha and Abraham, 2012).

Similarly, Unani medicine emphasizes the balance of humors through herbal decoctions, essential oils, and dietary modifications. Herbs such as Saffron (Crocus sativus) for neurological health and Black seed (Nigella sativa) for respiratory and digestive disorders are widely used (Rahman, 2018). Modern scientific research has validated the pharmacological effects of many of these medicinal plants, leading to their integration into contemporary pharmaceuticals and nutraceuticals (Patwardhan and Mashelkar, 2009). Additionally, Naturopathy promotes healing through plant-based diets, herbal infusions, and hydrotherapy, further reinforcing the importance of natural remedies in healthcare (WHO, 2019).

The global interest in herbal medicine has led to advancements in standardization and clinical research, making these remedies more widely accepted in integrative healthcare. However, challenges such as quality control, dosage standardization, and regulatory frameworks need to be addressed for their broader acceptance in modern medicine (Mukherjee *et al.,* 2017). As research continues, natural and herbal remedies remain a cornerstone of traditional medicine, offering sustainable, effective, and culturally relevant healthcare solutions.

14.5.4 Detoxification and Rejuvenation

Panchakarma in Ayurveda and various Siddha and Unani therapies help eliminate toxins from the body, rejuvenating internal organs and improving longevity. Detoxification and rejuvenation are fundamental principles in traditional Indian medicine, particularly Ayurveda, Siddha, and Naturopathy, where cleansing the body of toxins (Ama) is considered essential for maintaining health and preventing diseases. Panchakarma, the most well-known detoxification therapy in Ayurveda, consists of five purification procedures: Vamana (therapeutic emesis), Virechana (purgation), Basti (medicated enema), Nasya (nasal cleansing), and Raktamokshana (bloodletting). These therapies aim to remove accumulated toxins, balance the doshas (Vata, Pitta, and Kapha), and restore physiological harmony (Patwardhan *et al.,* 2005). Research suggests that Panchakarma significantly improves metabolic function and enhances immune responses (Mukherjee *et al.,* 2017).

Similarly, Siddha medicine incorporates detoxification through Kayakarpam therapy, which includes herbal purification, dietary modifications, and yogic practices to eliminate toxins and promote longevity (Sujatha and Abraham, 2012). Unani medicine employs regimental therapies such as cupping (Hijama), leech therapy, Turkish baths, and massage therapies for detoxification and revitalization of the body (Rahman, 2018).

Naturopathy focuses on non-invasive detoxification methods, including fasting, hydrotherapy, mud therapy, and plant-based diets, to cleanse the digestive system, boost energy levels, and improve overall health (WHO, 2019). Studies have shown that naturopathic detoxification can enhance liver function, reduce oxidative stress, and aid in weight management (Patwardhan and Mashelkar, 2009).

Rejuvenation therapies, such as Rasayana in Ayurveda, emphasize tissue regeneration, slowing aging, and enhancing mental clarity. Herbs like Ashwagandha (Withania somnifera), Amla (Emblica officinalis), and

Shatavari (Asparagus racemosus) are widely used for their antioxidant, adaptogenic, and immune-boosting properties (Mukherjee *et al.,* 2017). The increasing interest in natural and holistic wellness has led to a renewed focus on traditional detoxification practices, supporting their integration into modern healthcare.

14.6 Relevance Of Traditional Medicine in Modern Healthcare

With the rise of **lifestyle diseases** such as diabetes, hypertension, cardiovascular disorders, and mental health issues, traditional Indian medicine is gaining global recognition for its effectiveness in long-term disease management. Several Ayurvedic and herbal formulations have shown **scientific evidence** for their therapeutic benefits. **Yoga and meditation** are now widely adopted for stress management, mental health, and overall fitness.

Governments and global organizations, including the **World Health Organization (WHO)**, are encouraging the integration of traditional medicine into modern healthcare systems. India's Ministry of AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homeopathy) has been actively working on standardizing and promoting traditional medical practices. However, challenges such as **regulatory frameworks, lack of large-scale clinical trials, and standardization of formulations** need to be addressed for broader acceptance.

14.7 Traditional Indian Approaches to Disease Management

Traditional Indian medicine encompasses various holistic healing systems, including Ayurveda, Siddha, Unani, Yoga, and Naturopathy, each focusing on restoring the body's natural balance and enhancing overall well-being. Ayurveda, one of the world's oldest medical systems, is based on the Tridosha theory, which classifies individuals according to three fundamental bodily energies Vata, Pitta, and Kapha (Sharma and Chandola, 2011). Disease is believed to result from an imbalance in these doshas, and treatment involves herbal medicines, dietary modifications, detoxification therapies such as Panchakarma, and lifestyle adjustments (Patwardhan *et al.,* 2005).

Siddha medicine, originating in Tamil Nadu, incorporates a comprehensive approach to disease management by using herbs, minerals, and animal products in its formulations. It also integrates yoga, meditation, and dietary regulations to promote longevity and well-being (Sujatha and Abraham, 2012).Unani treatments include herbal formulations, diet therapy, and regimental practices such as cupping, massage, and hydrotherapy to restore humoral equilibrium (Rahman, 2018).

In addition to these medical systems, Yoga and Naturopathy play a significant role in disease prevention and health promotion. Yoga, with its combination of asanas (physical postures), pranayama (breath control), and meditation, is widely used to enhance physical strength, reduce stress, and support mental well-being (Telles *et al.,* 2009). Naturopathy, on the other hand, emphasizes non-invasive natural healing methods, including fasting, hydrotherapy, mud therapy, and plant-based diets, to detoxify the body and enhance self-healing (WHO, 2019).These traditional Indian approaches are increasingly being recognized for their potential to complement modern medicine, particularly in preventive healthcare, chronic disease management, and mental wellness. As scientific research continues to validate their efficacy, their integration into contemporary healthcare systems offers holistic, personalized, and sustainable treatment solutions shown in table-14.1.

Table 141: Traditional indian approaches to disease management

Traditional System	**Principles**	**Treatment Methods**	**References**
Ayurveda	Based on the Tridosha theory (Vata, Pitta, Kapha) and the balance of bodily energies	Herbal medicines, dietary modifications, Panchakarma detoxification therapies, lifestyle changes	Sharma and Chandola (2011); Patwardhan *et al.* (2005)
Siddha	Emphasizes natural elements (herbs, minerals, animal products) for disease prevention and treatment	Herbal remedies, mineral-based formulations, yoga, and meditation	Sujatha and Abraham (2012)
Unani	Based on the balance of four humors (blood, phlegm, yellow bile, black bile)	Herbal formulations, diet therapy, regimental therapies (cupping, massage, hydrotherapy)	Rahman (2018)

Traditional System	Principles	Treatment Methods	References
Yoga and Naturopathy	Focuses on physical, mental, and spiritual well-being	Yoga (asanas, pranayama, meditation), Naturopathy (fasting, hydrotherapy, mud therapy, plant-based diets)	Telles *et al.* (2009)

Ayurveda

Ayurveda, one of the world's oldest medical systems, is based on the principles of the Tridosha theory (Vata, Pitta, and Kapha) and the balance of bodily energies (Sharma andChandola, 2011). Treatment in Ayurveda includes herbal medicines, dietary modifications, Panchakarma detoxification therapies, and lifestyle changes (Patwardhan *et al.,* 2005).

Siddha

Originating from Tamil Nadu, Siddha medicine emphasizes the use of natural elements, including herbs, minerals, and animal products, for disease prevention and treatment. It also integrates yoga and meditation for overall well-being (Sujatha and Abraham, 2012).

Unani

The Unani system, influenced by Greek and Arabic medicine, follows the concept of balancing the four humors: blood, phlegm, yellow bile, and black bile (Rahman, 2018). It includes herbal formulations, diet therapy, and regimental therapies such as cupping and massage.

Yoga and Naturopathy

Yoga, an integral part of Indian tradition, promotes physical and mental health through asanas (postures), pranayama (breath control), and meditation (Telles *et al.,* 2009). Naturopathy emphasizes natural healing methods, including fasting, hydrotherapy, and mud therapy.

14.8 Relevance in Modern Healthcare

Traditional medicine remains highly relevant in modern healthcare, particularly as an integrative approach to disease management, preventive healthcare, and mental well-being. The integration of traditional medicine with conventional treatments has been increasingly recognized, with numerous studies highlighting the efficacy of Ayurvedic and herbal medicines in handling chronic diseaselike cardiovascular diseases (Patwardhan and Mashelkar, 2009). The World Health Organization (WHO) has also acknowledged the importance of traditional medicine in global healthcare, promoting its standardization and regulation (WHO, 2019).In addition to treatment, preventive healthcare is a major strength of traditional systems. Ayurveda, Siddha, and Unani emphasize dietary practices, detoxification, and stress management, which are highly relevant in addressing modern lifestyle diseases such as obesity, hypertension, and metabolic disorders (Mukherjee *et al.,* 2017). Traditional medicine also plays a crucial role in phytomedicine and drug development, as many modern pharmaceuticals, including anti-malarial and anti-cancer drugs, have their origins in medicinal plants used in ancient healing practices (Gurib-Fakim, 2006). Continued research on herbal formulations is uncovering new therapeutic applications, further bridging the gap between traditional knowledge and modern medicine. Moreover, traditional approaches to mental health and well-being have gained significant global recognition. Yoga and meditation have been widely adopted for their stress-reducing, mood-enhancing, and cognitive benefits, complementing modern psychological and psychiatric interventions (Gupta *et al.,* 2018). As the demand for holistic and patient-centric healthcare grows, the relevance of traditional medicine continues to expand, demonstrating its potential to complement modern medicine in providing sustainable, preventive, and personalized healthcare solutions shown in table-14.2.

Table 14.2: Relevance in modern healthcare

Aspect	Relevance in Modern Healthcare	References
Integration with Conventional Medicine	The integration of traditional medicine with conventional treatments has been increasingly recognized, with numerous studies highlighting the efficacy of Ayurvedic and herbal medicines in handling chronic diseaselike cardiovascular diseases.	Patwardhan and Mashelkar (2009); WHO (2019)

Aspect	Relevance in Modern Healthcare	References
Preventive Healthcare and Lifestyle Diseases	Traditional systems focus on preventive healthcare through dietary practices, detoxification, and stress management, which help combat modern lifestyle diseases.	Mukherjee *et al.* (2017)
Phytomedicine and Drug Development	Many pharmaceuticals, including anti-malarial drugs, have origins in medicinal plants. Research on herbal formulations continues to reveal new therapeutic potentials.	Gurib-Fakim (2006)
Mental Health and Well-being	Yoga and meditation have proven benefits in managing stress, anxiety, and depression, complementing modern psychological treatments.	Gupta *et al.* (2018)

Integration with Conventional Medicine

Many studies highlight the efficacy of Ayurvedic and herbal medicines in managing chronic diseases such as diabetes, arthritis, and cardiovascular disorders (Patwardhan and Mashelkar, 2009). The World Health Organization (WHO) has also recognized traditional medicine's role in global healthcare (WHO, 2019).

Preventive Healthcare and Lifestyle Diseases

Traditional systems emphasize preventive healthcare through dietary practices, detoxification, and stress management, which are relevant in combating modern lifestyle diseases (Mukherjee *et al.*, 2017).

Phytomedicine and Drug Development

Many modern pharmaceuticals, such as anti-malarial drugs, have origins in traditional medicinal plants (Gurib-Fakim, 2006). Research on herbal formulations continues to uncover new therapeutic potentials.

Mental Health and Well-being

Yoga and meditation have shown significant benefits in managing stress, anxiety, and depression, complementing modern psychological interventions (Gupta *et al.,* 2018).

14.9 Conclusion

Traditional Indian approaches to disease management offer valuable insights into holistic healthcare. Their principles of natural healing, disease prevention, and personalized medicine are increasingly relevant today. Integrating these systems with modern medical practices can provide a more comprehensive approach to healthcare, benefiting individuals worldwide. However, further scientific validation and standardization are necessary for their broader acceptance in global healthcare. Traditional Indian medicine continues to be highly relevant today as an alternative and complementary approach to modern healthcare. By combining **ancient wisdom with modern scientific advancements**, traditional systems can contribute significantly to disease prevention, management, and overall wellness. The increasing interest in integrative healthcare highlights the potential of these ancient practices in shaping the future of global health. The holistic approach of traditional Indian medicine offers **a comprehensive and natural way to maintain health and prevent diseases**. As research and clinical validation progress, traditional medicine can be effectively combined with modern therapeutic strategies for improved global healthcare.

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15

Ethnopharmacological Insights into the Phytochemistry and Therapeutic Potential of *Silybum marianum* (Milk Thistle)

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15.1 Introduction

Silybum marianum (L.) Gaertn., commonly known as milk thistle, is a member of the Asteraceae family and is native to the Mediterranean region, although it has naturalized in many other parts of the world, including Europe, Asia, and Northern Africa. The plant has a long history of medicinal use, dating back over 2,000 years. Ancient Greek physicians and herbalists documented its use for treating liver-related ailments and digestive issues. The name Silybum is derived from the Greek word "silybon," meaning "milk," which refers to the white veins on the plant's leaves that resemble milk. The term marianum is derived from the Virgin Mary, with legends suggesting the plant's association with her due to the milk-like streaks on its leaves.

Milk thistle has been used in traditional medicine for its liver-protective and detoxifying properties. It has been valued for its ability to treat a wide range of ailments, especially those related to the liver and digestive system. The plant's medicinal significance has been recognized in various traditional healing systems, particularly in Europe, the Middle East, and North Africa. Modern scientific research has focused on its active compound, silymarin, a flavonoid complex known for its antioxidant, anti-inflammatory, and liver-protective properties. Silymarin is a mixture of flavonolignans, including silybin, isosilybin, silychristin, and silydianin, which contribute to the plant's therapeutic effects.

15.2 Taxonomical And Botanical Details Of *Silybum Marianum*

Silybum marianum, commonly known as Milk Thistle, belongs to the family Asteraceae. It is an herbaceous plant known for its medicinal properties, primarily due to its active compound silymarin, which exhibits hepatoprotective, antioxidant, and anti-inflammatory effects.

15.2.1 Taxonomical Classification:

Kingdom: Plantae
Subkingdom: Tracheobionta (Vascular plants)
Superdivision: Spermatophyta (Seed plants)
Division: Magnoliophyta (Flowering plants)
Class: Magnoliopsida (Dicotyledons)
Order: Asterales
Family: Asteraceae (Sunflower family)
Genus: *Silybum*
Species: *Silybum marianum* (L.) Gaertn.

15.3 Botanical Description:

Silybum marianum is a robust, annual or biennial herbaceous plant that can grow up to 2 meters in height. The plant is characterized by its distinctive spiny leaves with white marbling patterns, which are believed to resemble the Virgin Mary's milk, giving it its common name.

- **Stem**: Erect, branched, and ribbed.
- **Leaves**: Alternately arranged, lobed, and covered with spiny edges; marbled white venation.
- **Flowers**: Bright purple to reddish-violet, borne in large, spiny, thistle-like flower heads.
- **Fruits**: Achene type, with a shiny black to brown pericarp and a pappus aiding wind dispersal.
- **Roots**: Taproot system, facilitating nutrient absorption in dry soils.

15.4 Habitat and Distribution:

Silybum marianum is native to the Mediterranean region but has been widely naturalized in various parts of Europe, North America, South America, Australia, and Asia. It thrives in dry, rocky, and disturbed habitats, including roadsides, pastures, and riverbanks.

15.5 Phytochemical Constituents

Silybum marianum is rich in a variety of phytochemicals, with the most significant being **silymarin**, a complex mixture of flavonolignans that contribute to its pharmacological properties. Silymarin consists primarily of silibinin (also known as silybin), isosilibinin, silychristin, and silydianin, with silibinin being the most biologically active component. These flavonolignans exhibit potent hepatoprotective, antioxidant, and anti-inflammatory properties, making *Silybum marianum* a valuable medicinal plant. In addition to flavonolignans, the plant contains flavonoids such as quercetin, taxifolin, and kaempferol, which enhance its antioxidant potential and contribute to its therapeutic effects.

Polyphenols present in *Silybum marianum* play a crucial role in neutralizing free radicals and protecting against oxidative stress-induced cellular damage. The plant also contains essential fatty acids, including linoleic acid, oleic acid, and palmitic acid, which exhibit anti-inflammatory properties and help regulate lipid metabolism. Furthermore, plant sterols such as campesterol, stigmasterol, and β-sitosterol contribute to cholesterol-lowering effects and immune modulation. The presence of alkaloids and saponins in minor quantities adds to the overall pharmacological activities of the plant, supporting its traditional use in herbal medicine. Additionally, *Silybum marianum* seeds contain a significant amount of proteins, while its essential oils contribute to the plant's aroma and therapeutic applications. The synergistic effects of these phytoconstituents make *Silybum marianum* a promising candidate for further pharmacological and clinical research (Pelter & Hänsel, 1968; Wagner *et al.,* 1976; Arnone *et al.,* 1979; Kaloga, 1981; Szilági *et al.,* 1981; Fiebig & Wagner, 1984; Lee & Liu, 2003; Samu *et al.,* 2004; Smith *et al.,* 2005; MacKinnon *et al.,* 2007; Sy-Cordero *et al.,* 2010; Qin *et al.,* 2017a; Qin *et al.,* 2017b).

History

Milk thistle (Silybum marianum) has a rich history of medicinal use, spanning thousands of years. Its use can be traced back to the ancient Greeks and Romans, who recognized its detoxifying and liver-protective properties. The Greek physician Dioscorides mentioned the plant in his writings, highlighting its potential for detoxifying and supporting liver health.

During the Middle Ages, milk thistle continued to be a staple in European herbal medicine. It was widely used for liver conditions and poisoning. The Renaissance saw further appreciation for its medicinal value, particularly for liver, gallbladder, and spleen conditions. Modern research has focused on its active compound, silymarin, a flavonoid complex known for its antioxidant, anti-inflammatory, and liver-protective properties.

In the 20th century, with the advent of modern science, milk thistle began to gain renewed attention. The discovery of silymarin led to clinical research on its efficacy in treating liver diseases such as cirrhosis, hepatitis, and fatty liver disease. Today, milk thistle is widely used as a dietary supplement, and its active compound, silymarin, is commonly extracted and marketed for its health benefits, particularly in supporting liver health.

Economics

Silybum marianum is not only cultivated for its medicinal properties but also as an ornamental plant and minor vegetable. It is an important food source in many countries and is grown commercially in Iran and Pakistan. The plant's economic significance is further highlighted by its potential as a biomass crop for bio-energy production. Its average annual sale is approximately US$ 8 billion, with a demand of 18 to 20 tons per year. Extracts of silymarin are marketed under various brand names, such as Livergol, Silipid, and Legalon.

Suspension and Callus Culture Reports

In 2000, Alikaridis et al. evaluated the flavonolignan content in root cultures of Silybum marianum (SM). The study revealed that silybin, isosilybin, silychristin, and silydianin were detected in untransformed root cultures, while only isosilybin was found in "hairy" root cultures (Alikaridis *et al.,* 2000).

Subsequent research by Sampedro et al. demonstrated that the production of flavonolignans could be significantly enhanced by altering medium conditions. For instance, treatment of cultures with the calcium ionophore A23187 did not affect silymarin accumulation, but treatment with the Ca2+ chelator EGTA increased silymarin levels by 200% (Sampedro *et al.,* 2005a). Another study by Sampedro et al. reported that methyl jasmonate strongly improved silymarin accumulation and enhanced chalcone synthase activity. However, the temporal relationship between silymarin accumulation and the increase in enzyme activity was not recorded (Sampedro *et al.,* 2005b).

Furthermore, the presence of an arabinogalactan protein and its amino acids was detected in cell suspension cultures using the Yariv reagent. In cultures of SM roots derived from in vitro germinated sterile plantlets and treated with hormone-free Murashige and Skoog medium, the primary flavonolignans detected were silychristin, silydianin, and the flavonolignan precursor taxifolin, with concentrations of 74.2, 8.1, and 40.8 μg/g of fresh weight, respectively (Elwekeel *et al.*, 2012). Methyl jasmonate treatment also enhanced the accumulation of flavonolignans and taxifolin by approximately 300% compared to control cultures and increased the content of 3,3',5,5',7-pentahydroxyflavanone (Elwekeel *et al.*, 2012).

Rady et al. conducted research on the development of callus and shoot cultures from leaves and shoot tips explants using various concentrations of the precursor coniferyl alcohol. They found that the optimal medium for maintaining friable callus and proliferating a high number of shoots contained 0.25 mg L-1 of each agent in the formula: 2,4-dichlorophenoxyacetic acid, kinetin, benzyl adenine, and naphthalene acetic acid (Rady *et al.*, 2014). Silymarin accumulation in callus cultures was significantly increased when treated with coniferyl alcohol at a concentration of 30 μM (Rady *et al.*, 2014).

An in-depth study on the influence of medium conditions on silymarin accumulation in suspension cultures from seedlings of three typical chemotypes revealed that the accumulation of regioisomers silydianin and silychristin was strongly dependent on the taxifolin: coniferyl alcohol concentration ratio (Poppe & Petersen, 2016). Additionally, the light quality influenced biochemical indexes in in vitro grown leaf-derived callus cultures of Silybum marianum. Superoxide dismutase activities were strongly promoted under red light conditions, while the highest peroxidase activities were recorded in dark-grown cultures. The highest flavonolignan accumulation was observed under red and green spectrum conditions (Younas *et al.*, 2018).

15.8 Extraction Method Reports

15.8.1 Alcoholic Extraction

Alcoholic extraction methods have shown that silymarin content is highest in tinctures with a concentration ratio of 1:1 (kg/L) and an alcoholic content of 70% (Pendry, n.d.). Effective doses were detected only in tinctures with this specific concentration ratio and alcoholic content. To increase polarity, the alcoholic extract of the fruits was loaded onto a silica gel column, and the column was eluted with benzene-ethyl acetate. Silymarin was isolated from the eluate by methanol precipitation, yielding 86% pure silybin (Pendry, n.d.). However, this method is uneconomical for industrial-scale use due to the costly step of silica gel column chromatography.

15.8.2 Water Extraction

Water extraction has been explored as a green solvent, with the benefit of low purchase costs and no need for a defatting step (Kumar *et al.,* 2011). Hot water has been advised as a suitable solvent for extracting silymarin from milk thistle. The technical indexes can be controlled by adjusting temperature and pressure. Interestingly, the defatting step is not required, and the extraction time decreases with increasing temperature. However, high temperatures could degrade silymarin content, which is a primary defect of this approach.

15.8.3 Advanced Extraction Methods

Advanced extraction methods have demonstrated higher silymarin content in pericarp extracts compared to whole fruit extracts (Elwekeel *et al.,* 2012). One such method involves determining the silymarin content in the pericarp extract and comparing it to that of the whole fruit extract using two orthogonal analytical methods. The silymarin content of the pericarp extract was found to be higher (2.24-fold by HPLC and 2.12-fold by qHNMR) compared to the acetone extract of whole fruits with hexane as a defatting solvent. The methanol pericarp extract had the highest silymarin content, which was 2.72-fold higher than the acetone extract of whole fruits (Elwekeel *et al.,* 2012).

15.9 Pharmacological Activity Reported

Antioxidant Activity

Antioxidant activity is one of the most studied pharmacological properties of Silybum marianum. Studies have evaluated the antioxidant activity of milk thistle extracts using various assays, including DPPH-scavenging activity, ABTS, and FRAP assays. For instance, Admah et al. (2013) reported DPPH-scavenging activity in extracts from intact plants and leaves, with maximum activity observed in 80-day-old plants. However, the study's methodology and results have been questioned due to inconsistencies in reported values and the lack of comprehensive assays (Lucini *et al.,* n.d.). Other studies have shown that constituents of milk thistle exhibit higher antioxidant capacity compared to positive controls in ABTS and FRAP assays (Nazir *et al.,* 2018).

Anti-inflammatory Effects

Compounds isolated from Silybum marianum, such as (1R, 7R, 10R, 11R)-12-hydroxyl anhuienosol and others, have demonstrated potent NO inhibitory effects in murine microglial BV-2 cells (Qin *et al.,* 2017b). These findings suggest that milk thistle extracts may have potential therapeutic applications in reducing inflammation and oxidative stress.

Antiviral Activities

Silibinin from milk thistle has shown antiviral activity against herpes simplex virus type 2 (HSV-2) with an IC50 value of 100 μg/mL and a therapeutic index of 3.8 (Qin *et al.,* 2017b). This compound exhibited a more potent virucidal effect with an IC50 of 5 μg/mL and a therapeutic index of 76. These results highlight the potential of milk thistle extracts in treating viral infections.

Antidiabetic Activities

Maghrani *et al.* (2004) reported the hypoglycaemic effect of aqueous extracts from Silybum marianum aerial parts in both normal and streptozotocin diabetic rat models. Silychristin A has also been shown to decrease glucose levels, increase insulin secretion, and improve the structure of beta cells in tested rats (Qin *et al.,* 2017b). Clinical trials have indicated that silymarin supplementation can improve glycemic indices and lipid profiles in type-2 diabetes mellitus patients (Qin *et al.,* 2017b). These findings suggest that milk thistle may have potential therapeutic applications in managing diabetes.

Anti-amnesia Effects

Methanol extracts of Silybum marianum seeds have exhibited concentration-dependent inhibition of acetylcholinesterase and butyrylcholinesterase, with IC50 values of 110 and 130 μg/mL, respectively (Nazir *et al.,* 2018). These extracts have also shown anti-amnesia capacity in scopolamine-induced amnesia animal models (Nazir *et al.,* 2018). These results suggest that milk thistle may have potential therapeutic applications in treating cognitive disorders.

Cardioprotective Effects

A study evaluated the cardioprotective effects of Silybum marianum in a pig trial model, showing that it limits adverse remodeling post-myocardial infarction by mitigating oxidative stress and reactive fibrosis (Federico *et al.,* 2017). However, the study's methodology and the choice of oxidative stress markers have been critiqued for not providing a comprehensive analysis of the total antioxidant status (Federico *et al.,* 2017). These findings suggest that milk thistle may have potential therapeutic applications in protecting against cardiovascular diseases.

Hepatic Protection

Ethanol and ethyl acetate seed extracts have been tested against carbon tetrachloride-induced liver damage, with ethanol extract showing significant decreases in liver enzymes and ethyl acetate extract increasing glutathione levels (Abenavoli *et al.,* 2010). Silymarin has also been shown to attenuate non-alcoholic steatohepatitis in rats by reducing lipid accumulation, oxidative stress, and inflammation (Zhu *et al.,* n.d.). These findings highlight the potential of milk thistle extracts in treating liver diseases.

Wilson's Disease

It has been suggested that milk thistle products with high copper content should be limited for Wilson disease patients due to the risk of copper overload (Abenavoli *et al.,* 2010). This recommendation highlights the need for caution in using milk thistle supplements in patients with specific metabolic disorders.

Obsessive-Compulsive Disorder

A double-blind, randomized trial showed that Silybum marianum extract was as effective as fluoxetine in treating obsessive-compulsive disorder, although the herbal medication's effects were observed one week later (Abenavoli *et al.,* 2010). These findings suggest that milk thistle may have potential therapeutic applications in treating psychiatric disorders.

Sepsis and Burn Prevention

Silymarin has been shown to reduce sepsis-induced remote organ injury by balancing oxidant-antioxidant status and regulating inflammatory mediators (Toklu *et al.,* n.d.). It has also been reported to protect against burn-induced oxidative skin injury by reducing oxidative damage and increasing glutathione levels (Toklu *et al.,* n.d.). These findings highlight the potential of milk thistle extracts in treating sepsis and burns.

Application in Veterinary Medicine

Dietary supplementation with Silybum marianum has been shown to reduce mortality rates in rabbits under oxidative stress and improve the sanitary status of commercial rabbit farms (Khan *et al.,* 2013). However, the impact on growth performance and blood biochemical indexes has been mild, with no significant effects on most markers of oxidative stress (Khan *et al.,* 2013). These findings suggest that milk thistle may have potential therapeutic applications in veterinary medicine.

15.10 Conclusion

Silybum marianum (SM) has garnered significant attention due to its therapeutic benefits. While pharmacological studies have been conducted in vitro and in vivo, the comprehensive pharmacological mechanisms of SM need further elucidation. Based on phytochemical and pharmacological research, silymarins have been identified as key compounds responsible for anti-diabetic, anti-amnesia, and hepatic-protective activities, serving as chemical markers for evaluating the quality of SM and its products (Stickel & Schuppan, 2007; Federico *et al.,* 2017; Abenavoli *et al.,* 2010; Saller *et al.,* 2001).

Future research should focus on further exploring the pharmacological mechanisms of milk thistle and its active compounds. Additionally, clinical trials are needed to confirm the therapeutic potential of milk thistle in various health conditions. The development of standardized extraction methods and quality control measures will also be crucial for ensuring the consistency and efficacy of milk thistle products.

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16

The Contribution of Indian Knowledge to the Advancement of Natural Products in Pharmaceutical Care

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16.1 Introduction

Natural products (NPs) play a critical role in the development of therapeutics, especially for chronic conditions and other medical applications (Atanasov *et al.,* 2021). Unlike traditional synthetic drugs, NPs possess unique characteristics, but incorporating them into active drug molecules presents several challenges (Harvey *et al.,* 2015). NPs offer an extensive range of structural diversity compared to chemical compound libraries, often featuring higher molecular weights, a significant number of carbon and oxygen atoms, as well as more hydrogen bond acceptors and donors,. and increased molecular rigidity (Feher and Schmidt, 2003). These traits can be advantageous; for example, the enhanced rigidity of NPs may aid in the drug development process. Evolution has structurally "optimized" NPs to perform specific biological functions, such as regulating internal protective mechanisms and interacting (often competitively) with other species, which underscores their value in treating chronic and infectious diseases (Li and Vederas, 2009). Furthermore, their use in traditional medicine may provide valuable insights into their safety and efficacy (Barnes *et al.,* 2016). Compared to traditional synthetic small-molecule libraries, natural products (NPs) contain a greater abundance of 'bioactive' molecules, offering a broader range of synthetic chemistry

(Clardy and Walsh, 2004). Despite the potential and numerous successful examples, pharmaceutical companies have scaled back drug development efforts based on NPs due to various limitations. Screening for NPs often involves a library of natural product extracts, which may not be compatible with conventional target-based assays (Atanasov *et al.,* 2021). Identifying the relevant bioactive molecules can be challenging, and dereplication strategies are necessary to avoid re-examining previously discovered compounds (Cragg *et al.,* 1993). The standardization and optimization of herbal resources for primary healthcare in rural populations are often not prioritized due to their perceived sufficient reliance on traditional methods. In low- and middle-income countries, natural medicines or plant-based products are typically used in their crude or partially purified forms, often extracted in water. Numerous studies are being conducted to identify and isolate the active compounds involved in treatment (Dzobo, 2021). However, the extraction process can sometimes lead to a reduction in the therapeutic efficacy and curative properties of these plant components. Additionally, these preparations can have varying effects on biological systems, making it crucial to understand their molecular mechanisms.

Natural compounds and plant-based substances are challenging to study, as they are mixtures of metabolites and their activity can change once removed from their natural environment (Li and Weng, 2017). When developing pharmaceuticals from natural products, a balanced approach is needed to maintain their bioactivity (Tollefson and Gilbert, 2012). However, when native communities or industries incorporate a pharmaceutical perspective, a scientific approach becomes essential for ethnomedicine, aligning it with modern medical practices (Moffat *et al.,* 2017). Given the diverse chemical structures found in natural substances, there is significant potential to discover new molecules that could be developed into medications. Major pharmaceutical companies like Merck, Johnson & Johnson, Pfizer, and Novartis are actively exploring and commercializing natural products for drug development (Beutler, 2019).

16.2 Challenges in Natural Product-Based Drug Development

There are 422,000 documented plant species worldwide, with 52,000 (or 12.5%) used for medicinal purposes, and 8% classified as 'threatened' (U. Schippmann *et al.,* 2002). Many plants have yet to be explored for their pharmacological potential, and only a small number have been recognized and included in official pharmacopoeias, such as the Japanese and Ayurvedic Pharmacopoeias. The 14th edition of the Japanese Pharmacopoeia lists 165 herbal constituents, while the 16th edition specifies 276 crude pharmaceuticals, including herbal medicines and extracts used in Kampo treatments (Pan *et al.,* 2014). The Indian Ayurvedic Pharmacopoeia includes 976 component formulations and 540 plant monographs (Joshi *et al.,* 2017).

Phytoconstituents in plants are responsible for their pharmacological activities, and the content of these compounds can vary based on the plant's growth habits. A plant's habit plays a significant role in determining its therapeutic value. In India, about 90% of medicinal plants used in Ayurveda are sourced from wild and natural environments. However, improper harvesting practices, such as collecting plants at the wrong maturity stage, improper drying, and prolonged storage, are rapidly depleting these resources and putting many species at risk (Lalitha, 2013). Several challenges hinder the drug development process from natural products: the plant's habitat and collection methods, proper cultivation of medicinal plants, environmental challenges impacting productivity, the identification of active ingredients in these plants, and the strategies for scaling up production to meet demand.

16.3 Sources and Classification of Natural Products

Natural products (NPs) and their derivatives have long been recognized as valuable sources of therapeutic agents. NPs are biologically active compounds derived from natural sources, including plants, animals, and microbes (Baker *et al.,* 2007). As shown in Fig. 1, they are classified into four categories based on their respective biosynthetic origins. For example, plant NPs are often referred to as secondary metabolites. These are compounds produced by plants that are not essential for reproduction, growth, or development but are generated in response to environmental factors or as a defense mechanism against predators. In both cases, these metabolites are synthesized to enhance the plant's survival (Dewick, 2009). The wide range of natural substances is influenced by several factors, particularly the vast biodiversity of aquatic and terrestrial species, which produce various molecular structures with diverse biological activities (Dias *et al.,* 2012).

16.4 Herbal Medicine and Modernity

Herbal medicine stands out as a timeless practice, having endured through the ages. Yet, despite its potential, its use in disease management remains limited. Many ethnic and rural communities continue to rely on and preserve ancient plant-based medicinal knowledge, ensuring it does not fade into obscurity. There is a growing call for the revival of herbal medicine. However, integrating it into modern healthcare while adhering to contemporary safety and efficacy standards remains a challenging task.

16.5 Revival of Indian Traditional Herbal Medicine: Current Situation And Challenges

Indian traditional medicinal systems (ISMs), particularly Ayurveda, are gaining global recognition, and there are significant efforts to incorporate herbal medicine into modern medicine. India boasts a wealth of research facilities, including the Central Drug Research Institute (CDRI), the Council of Scientific and Industrial Research (CSIR), and several others, which play a crucial role in this process. Many organizations, both governmental and non-governmental, across various countries have begun researching plants and formulations described in Ayurveda.

16.6 Indian Traditional Medicinal Plants in Preclinical and Clinical Trials

The global acceptance of Ayurveda is rising, along with an increased demand for medicinal plants from India. Recently, numerous drugs derived from ISMs have undergone clinical trials to validate their efficacy. Ayurvedic products have shown positive results in the treatment of conditions like bronchial asthma, rheumatoid arthritis, ischemic heart disease, and cancer. Key medicinal herbs like ashwagandha, guggulu, haridra, and amla, among others, have been evaluated through preclinical studies, showing promising effects. Notably, the U.S. National Center for Complementary and Alternative Medicine has funded research on Ayurvedic remedies, such as the use of curcuminoids for cardiovascular diseases, a compound from M. pruriens for anti-Parkinson's drug side effects, and the effects of Centella asiatica in treating Alzheimer's disease.

Clinical trials are crucial for establishing the effectiveness of these drugs and comparing their potency with allopathic treatments. Many clinical trials of Indian traditional medicines have yielded positive results, but further studies are necessary. For example, "piperine," a bio-enhancer from *Piper longum*, has been successfully evaluated in clinical trials. Other promising products include a hypoglycemic drug derived from *Pterocarpus marsupium* and a herbal anti-psoriatic drug containing *Argemone mexicana*, among others. The CSIR and CDRI have also developed a bacoside-enriched extract of *Bacopa monnieri*, used for enhancing memory and learning, which is now marketed internationally.

16.7 Traditional Medicinal Formulations

Several classical Ayurvedic formulations have undergone clinical trials with positive results. For example, "triphala," a well-known Ayurvedic blend of *Terminalia chebula*, *Terminalia bellerica*, and *Emblica officinalis*, has shown effectiveness in treating constipation and other digestive issues. A formulation combining *ashwagandha*, *guggulu*, and *haldi* has been effective in treating joint swelling in rheumatoid arthritis patients. Other examples include "pros-talyn," a combination of two Indian medicinal plants used to treat benign prostate hyperplasia, and "Guduchyadi ghrita medhya rasayana," which has demonstrated promising effects in improving memory, stress, and depression, possibly slowing down aging.

16.8 Promising Natural Products in Drug Discovery

Natural products have garnered significant attention for their potential in cancer prevention and treatment. Unlike conventional chemotherapy drugs, which often come with severe side effects such as immunosuppression, liver, kidney, and heart toxicity, natural compounds offer greater safety and efficacy. These include phenols like curcumin, quercetin, and resveratrol, flavonoids like quercetin and icariin, terpenoids like andrographolide and artesunate, and alkaloids like berberine and piperine. These compounds exhibit anti-inflammatory properties, induce apoptosis in cancer cells, and inhibit invasion and metastasis, making them effective against various cancers such as lung, breast, and ovarian cancer. Natural products hold considerable promise in the development of safer, more effective cancer treatments.

16.9 The Contribution of Indian Knowledge to the Advancement of Natural Products in Pharmaceutical Care

Indian traditional medicinal systems, particularly Ayurveda, have made significant contributions to the field of natural products in pharmaceutical care. These systems have a rich history of utilizing plant-based remedies, minerals, and animal products to prevent and treat a wide range of health conditions. Over thousands of years, Ayurvedic knowledge has developed an intricate understanding of plant properties and their therapeutic uses, which is now being increasingly integrated into modern pharmaceutical practices.

- **Ancient Wisdom and Modern Integration:** Indian traditional medicine has long emphasized the holistic nature of healing, focusing not just on physical symptoms but also on mental and emotional well-being. This approach has provided a foundation for the development of natural products that target multiple aspects of health, ensuring that modern pharmaceutical care can benefit from this comprehensive understanding. With the growing interest in herbal medicines globally, Ayurvedic formulations have found their place in modern pharmaceutical research, leading to the development of novel treatments.
- **Identification of Active Compounds:** Indian knowledge systems have contributed immensely to the discovery of bioactive compounds from plants that have potential pharmaceutical applications. For instance, compounds such as curcumin from *Curcuma longa*(turmeric), piperine from *Piper longum*, and withaferin A from *Withania somnifera* (ashwagandha) have shown significant therapeutic effects, including anti-inflammatory, antioxidant, anticancer, and neuroprotective properties. The systematic study of these compounds, based on traditional knowledge, has opened doors to their clinical application in treating various chronic diseases, including cancer, diabetes, and neurological disorders.
- **Herbal Formulations in Clinical Use:** Ayurvedic and Siddha systems have long utilized complex plant-based formulations to treat a range of diseases. These formulations, often made from combinations of herbs, minerals, and animal products, are now being researched for their efficacy and safety in clinical trials. Products like "Triphala," "Ashwagandha," and "Guduchi" have shown promising results in clinical settings for improving immunity, enhancing cognitive function, and treating metabolic disorders. The increasing integration of these traditional formulations into modern healthcare highlights the potential of natural products in pharmaceutical care.
- **Phytochemical Research and Drug Development:** Indian research institutes, such as the Central Drug Research Institute (CDRI) and the Council of Scientific and Industrial Research (CSIR), have made significant strides in isolating and studying phytochemicals from Indian medicinal plants. For example, *Bacopa monnieri* (Brahmi), which has been used for centuries to improve memory and cognition, has now

been formulated into standardized extracts used for cognitive enhancement. The development of such products based on Indian herbal knowledge is not only expanding the pharmaceutical industry but also supporting the trend of personalized medicine with plant-based therapies.

- **Global Acceptance and Market Demand:** The increasing acceptance of Ayurveda and traditional Indian medicine across the globe has led to a surge in demand for Indian medicinal plants and products. With growing interest in natural and organic products, many pharmaceutical companies are exploring the therapeutic potential of Indian herbs and their active ingredients. As a result, the global market for herbal medicine is expanding, and products derived from Indian knowledge systems are becoming an integral part of the modern healthcare landscape.
- **Sustainability and Biodiversity:** India's rich biodiversity provides an invaluable resource for the development of natural products. Indian knowledge systems have long emphasized sustainability and the importance of maintaining ecological balance, principles that are now being applied in the cultivation and harvesting of medicinal plants. This sustainable approach ensures that natural products used in pharmaceutical care are not only effective but also environmentally friendly, offering a path forward in the search for alternative treatments that minimize the ecological footprint (Joshi *et al.,* 2017).

16.10 Conclusion and Future Prospects

Natural products will remain a valuable and dependable source for the development of pharmaceutical drugs. Identifying the right methods for drug development from biological substances is crucial. Many of the advancements in drug discovery are part of an ongoing effort to transform herbal remedies into commercial medications. It is well established that researchers have explored compounds with therapeutic potential from herbal medicines. While indigenous knowledge about plants and pharmacologically assisted drug development from natural products offers practical advantages, these approaches can be time-consuming and yield low productivity. Plant-based therapeutics play an important role in assisting researchers in creating new medications by revealing potential harmful effects. However, innovative strategies are needed to improve the development of drugs from natural products. To achieve this, new methodologies focused on natural products have facilitated the discovery and development process, transforming natural compounds into active pharmaceutical agents. In this context, technological advancements have allowed for the study of complex chemical properties, leading to the development and synthesis of numerous molecules. Recently, several breakthrough medications have been derived from natural substances or components sourced from natural resources.

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17

Influences on Nurses Attitude Towards Clinical Research: A Perspective on Integrating Traditional and Modern Medicine

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17.1 Introduction

Clinical research is essential for discovering new drugs and medical devices for treating diseases and new ways to detect, diagnose and lower the chances of developing the disease. India is one of the preferred destinations for conducting clinical trials by the pharmaceutical industry. Lower costs for conducting clinical trials and the availability of a large patient population are some of the reasons for this choice (Gupta *et al.,* 2011). According to a report, in 2020 India contributed an 8.3% proportion of worldwide clinical trials activity, an increase over the previous ten-year average of 6.2% (Clinical Trials Analysis, 2021). As the number of trials in India will increase the demand for manpower trained according to good clinical practice (GCP) guidelines will also increase. Clinical research team members must be competent, have essential education, have high skill levels, and work well together for it to be successful (Furaikh *et al.,* 2017). A Clinical Research Nurse (CRN) or staff nurse involved in the care of clinical trial patients is one of the vital members of this multidisciplinary research team. CRN have responsibilities ranging from obtaining and maintaining patient consent forms, implementing the study protocol, administration of study interventions and care of the trial patients (Hastings *et al.,* 2012).

Understanding clinical research and knowledge about ethical conduct are prerequisites for nurses to accomplish these responsibilities as clinical care and clinical research are very different. In clinical care, patients are given interventions whose safety and effectiveness are already established whereas in clinical research the interventions are given that may or may not be of immediate benefit to the patient but generate data for the benefit of future patients (Grady and Edgerly, 2009).

Clinical research education has not been extensively integrated into nursing education systems. Studies have shown that the knowledge of nurses towards clinical research is low and nursing programs should expose students to clinical research (Alsleben *et al.,* 2018). A study exploring the awareness of clinical research among nurses showed that nurses have limited knowledge (Yanagawa *et al.,* 2014). Similarly, the study by Bulut Aksoy *et al.* (2018) showed that the knowledge level of nurses towards clinical research is low however the attitude of nurses towards clinical research was positive and are motivated about clinical research. Many studies have found that time constraints, lack of knowledge and opportunities in clinical research are important barriers to the involvement and participation of nurses in clinical trials (Kao *et al.,* 2019). The knowledge if low can be improved with adequate training however having the right attitude is very important. A study conducted among nurses showed that the attitude of nurses is influenced by demographic factors like age and work experience. The authors also reported that older nurses were less interested in research activities (Jacobson *et al.,* 2008). Another study reported that the work settings of the nurses influenced their attitude toward patient participation in clinical trials (Burnett *et al.,* 2001).

Previously conducted studies reported that the work settings of the nurses influenced their attitude. Most of the studies exploring the attitude of nurses towards clinical research have been in countries other than India. Moreover, the majority of the previous studies were limited to a specific unit/speciality. The current study aimed to assess the attitude of the nurses towards clinical research in general settings with the objective, to analyse the factors influencing their attitude towards clinical research.

17.2 Methods

17.2.1 Study Design

The study was a descriptive cross-sectional survey among nurses. The study was conducted among registered nurses working in government and private hospitals. The survey was conducted in both offline and online mode. For data collection in offline mode, the private and semi-government hospitals in Jalandhar City of Punjab were visited. The online data was collected by circulating the study questionnaire through e-mail and other social media platforms. Through online mode, the data was collected from government teaching and tertiary care hospitals from other regions of the country.

Data Collection Tool

The data was collected via a self-administered questionnaire. The questionnaire was designed based on the available literature (Hanibernia, 2018; Kao *et al.,* 2019). It consisted of two sections: Section 1: included demographic information. Section 2: included 20 questions about the nurses' attitude. 10 statements depicted positive questions and the other 10 statements depicted negative questions. A three-point Likert scale was used to examine the attitude of the nurses towards clinical research.

Statistical Analysis

The data obtained were entered into MS Excel and analysed using SPSS (version 29.0). The data are presented as frequency and percentage. Mann-Whitney U test and Kruskal Wallis statistics were utilized to find the association between the attitude towards clinical research and the demographics and other factors influencing attitude.1

17.3 Results

17.3.1 Participant Demographics

A total of 1006 nurses participated in the study. The questionnaire was administered in face-to-face mode to 501 nurses and through online platforms to 505 nurses. Data from 916 nurses were included in the final analysis, whereas data from 90 respondents were excluded. The data was excluded for those respondents who did not provide their demographic information (n=9), respondents who did not answer more than 50% of the questions (n=12) and respondents who discussed with their colleagues about the questionnaire and did not give independent answers and opinions (n=69). For demographic data, descriptive statistics were utilized to determine the frequency and percentage (Table 1). The majority of the nurses (66.20%) were female and the rest (33.70%) were male. The responses to the questionnaire were submitted by individuals across different age groups. Out of which, it was observed that the individuals in the age range 21-30 years showed maximum participation (70.63%). Most of the participants (70.63%) were working in private hospitals and only 3.93% belonged to PPP hospitals. The majority (81.60%) had work experience in the range of 1-10 years.

Table 1: Demographics of study participants

Characteristic	Categories	Frequency (n=916)	Relative frequency (%)
Gender	Female	607	66.20
	Male	309	33.70
Age	21-30	647	70.63
	31-40	212	23.14
	41-50	40	4.30
	>50	17	1.80
Qualification	Diploma	519	56.65
	Bachelor's Degree	321	35.04
	Master's Degree	76	8.29
Organization	Government	233	25.43
	Private	647	70.63
	PPP	36	3.93
Experience	<1	22	2.40
	1-10	748	81.60
	11-20	104	11.35
	21-30	42	4.50
Participated in Trial	Yes	112	12.22
	No	804	87.77

17.3.2 Attitude of Nurses Towards Clinical Research

A 3-point Likert scale (agree, neither agree nor disagree, disagree) was used. The options were allocated with numerical valuesto analyse the data. Out of a total of 20 statements, 10 statements were for the assessment of positive attitude and 10 statements for the assessment of negative attitude. For the positive attitude subscale, the total score ranged from 10 to 30, where a higher score showed a more positive attitude. Attitude score was regarded as positive attitude if the score was between 20 to 30, neutral attitude if the score lied between 15-19, and negative attitude if the score was between 10-14. For the negative attitude subscale, the total score ranged from 10 to 30, where a higher score indicated a more negative attitude toward clinical trials. Attitude score was regarded as negative attitude if the score ranged between 20 to 30, neutral attitude if the score was between 15 to 19, and positive attitude if the score range was 10 to 14 (Hanibernia, 2018).The weighted mean was computed to assess the overall attitude score of the nurses in the positive statements (Table 2). In the positive attitude sub-scale, the overall weighted mean was 25.47 which lay in the positive attitude range. Nurses believed that clinical research plays an important role in the advancement of medicines and medical devices and it is important to improve patient care. Participants also believed that clinical research has the potential to enhance the nursing profession. Therefore, clinical research should be included in the nursing education. The overall weighted mean score in the negative statements was 22.45 depicting the negative attitude of the nurses. Nurses agreed that they have concerns about the double-blinded random allocation of the participants, and about trial drug side effects which may be hard to handle by the physicians because it will be worse than the normal medication. Nurses also believed that participants may be treated as guinea pigs in the trials. Survey nurses were also concerned about the patients being allocated to placebo.

Table 2: Nurses response in positive and negative attitude questions

Item	Question	Weighted Mean	Question	Weighted Mean
Positive Attitude Statements			**Negative Attitude Statements**	
1	Clinical research is advantageous for the public	2.86	I'm concerned because patients are assigned treatments at random	2.30
2	Clinical trials refine status of patient treatment	2.82	Patients may be harmed as a result of the trial's unknown side effects	2.19
3	Clinical trials are critical to the advancement of medicine	2.54	In the placebo group, the patient's condition may be worse	1.97
4	Clinical research is important to add in medical knowledge and potentially improve patient care	2.58	Clinical research is a type of experimental treatment that can cause harm to patients	2.09
5	Patients enrolled in the study may receive better treatment than other patients	2.38	Clinical research will have an impact on your daily care and add to your workload	2.50

Item	Question	Weighted Mean	Question	Weighted Mean
6	Clinical research has the potential to enhance the nursing profession	2.61	As part of the trial process, patients may be required to undergo additional biopsies, scans, blood tests, and other procedures, which may interfere with their daily routine and quality of life	2.47
7	Should clinical research be included in nursing education	2.66	You may feel anxious when patients are in double-blind trials because you don't know what drug they will get	2.10
8	Clinical trials are a final resort for individuals who have exhausted all other therapy choices	2.11	I'm concerned that physicians will be unable to deal with the trial drug's side effects	2.37
9	Patients do not have to pay medical bills because the trial sponsors cover the costs of the study medicine and diagnostics	2.41	Patients participating in clinical trials may be treated as guinea pigs	1.95
10	Patients in clinical trials have more frequent interaction with the research team than they do with their regular doctor	2.50	I'm concerned that the trial drug's side effects will be worse than the normal medication	2.51
Total Score		25.47		22.45

17.3.3 Attitude Towards Significance of Clinical Research

The influence of demographic characteristics on attitude towards clinical research is depicted in table 3 and potential of clinical research in enhancing nursing profession in depicted in table 4. Male nurses showed a significantly more positive attitude in comparison with female nurses. A significantly higher number of male nurses agreed that clinical research is advantageous to the public and clinical research has the potential to enhance the nursing profession and it should be included in nursing education.Out of the 10 statements, in the 4 statements, the association between the previous participation and the positive attitude was found significant. Nurses who had previously participated in clinical trials believed more that clinical research has the potential to enhance the nursing profession and it should be included in nursing education. They also believed that clinical trials are critical in the advancement of medicine.Nurses working in government hospitals showed positive belief in the role of clinical research in the advancement of medical knowledge and patient care in clinical trials. A higher percentage of nurses working in government hospitals believed that clinical research has the potential to enhance the nursing profession and that clinical research should be included in nursing education.The educational qualification of the nurses significantly influenced the positive attitude of the nurses towards clinical research. A significantly higher percentage of "agree" was reported by nurses having master'squalifications in all the statements in comparison to nurses having diplomas.

The analysis showed that the percentage of agree responses in positive statements increased with age. Higher age group nurses believed that clinical research is critical in the advancement of medical knowledge and refinement of patient care. They also believed that clinical research can enhance the nursing profession and should be included in nursing education.As the experience increased the belief was stronger that clinical research is important for the advancement of medical knowledge and patient care and that clinical research has the potential to enhance the nursing profession.

Table 3: Attitude of nurses towards significance of clinical research

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Clinical research is advantageous for the public					
Gender N (%)	Male	292 (94.50)	3 (0.97)	14 (4.50)	*0.047
	Female	550 (90.60)	22 (3.62)	35 (5.76)	
Organization N (%)	Government	261 (97.00)	1 (0.40)	7 (2.60)	*<0.001
	Private	581 (89.80)	24 (3.70)	42 (6.50)	

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Qualification N (%)	Master's Degree	75 (98.70)	0 (0.00)	1 (1.30)	#0.040
	Bachelor's Degree	298 (92.80)	8 (2.50)	15 (4.70)	
	Diploma	469 (90.40)	17 (3.30)	33 (6.40) ^{A}	
Clinical trials refine status of patient treatment					
Organization N (%)	Government	255 (94.80)	9 (3.30)	5 (1.90)	*<0.001
	Private	562 (86.90)	30 (4.60)	55 (8.50)	
Qualification N (%)	Master's Degree	74 (97.40)	0 (0.00)	2 (2.60)	#0.032
	Bachelor's Degree	289 (90.00)	13 (4.00)	19 (5.90)	
	Diploma	454 (87.50)	26 (5.00)	39 (7.50) ^{A}	
Clinical trials are critical to the advancement of medicine					
Participated in the trial N (%)	Yes	88 (78.60)	12 (10.70)	12 (10.70)	*0.034
	No	553 (68.80)	118 (14.70)	133 (16.50)	
Organization N (%)	Government	229 (85.10)	25 (9.30)	15 (5.60)	*<0.001
	Private	412 (63.70)	105 (16.20)	130 (20.10)	
Qualification N (%)	Master's Degree	65 (85.50)	7 (9.20)	4 (5.30)	#0.011; 0.005
	Bachelor's Degree	220 (68.50)	52 (16.20)	49 (15.30) ^{A}	
	Diploma	356 (68.60)	71 (13.70)	92 (17.70) ^{A}	
Age group N (%)	21-30	438 (67.70)	103 (15.90)	106 (16.40)	#0.049
	31-40	156 (73.60)	23 (10.80)	33 (15.60)	
	41-50	35 (87.50)	3 (7.50)	2 (5.00) ^{C}	
Clinical research is important to add in medical knowledge and potentially improve patient care					

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Organization N (%)	Government	231 (85.90)	19 (7.10)	19 (7.10)	*<0.001
	Private	443 (68.50)	84 (13.00)	120 (18.50)	
Qualification N (%)	Master's Degree	69 (90.80)	2 (2.60)	5 (6.60)	#0.046; 0.000
	Bachelor's Degree	246 (76.60)	32 (10.00)	43 (13.40) [A]	
	Diploma	359 (69.20)	69 (13.30)	91 (17.50) [A]	
Age group N (%)	21-30	455 (70.30)	81 (12.50)	111 (17.20)	#0.013
	31-40	171 (80.70)	21 (9.90)	20 (9.40) [C]	
	41-50	35 (87.50)	1 (2.50)	4 (10.00)	
Experience N (%)	1-10 years	535 (71.50)	90 (12.00)	123 (16.40)	#0.029
	11-20 years	87 (83.40)	7 (6.70)	10 (9.60) [D]	
	21-30 years	35 (83.30)	2 (4.80)	5 (11.90)	

**Mann Whitney U Test; # Kruskal Wallis Test; [A] significant difference vs master degree; [B] significant difference vs bachelor degree; [C] significant difference vs age group 21-30 years; [D] significant difference vs experience 1-10 years.*

Table 4: Role of clinical research in nursing profession

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Clinical research has the potential to enhance the nursing profession					
Gender N (%)	Male	255 (82.50)	13 (4.20)	41 (13.30)	*0.003
	Female	441 (72.70)	75 (12.40)	91 (15.00)	
Participated in the trial N (%)	Yes	97 (86.60)	5 (4.50)	10 (8.90)	*0.006
	No	599 (74.50)	83 (10.30)	122 (15.20)	
Organization N (%)	Government	250 (92.90)	9 (3.30)	10 (3.70)	*<0.001
	Private	446 (68.90)	79 (12.20)	122 (18.90)	

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Qualification N (%)	Master's Degree	73 (96.10)	1 (1.30)	2 (2.60)	$^{\#}$0.009; <0.001; 0.012
	Bachelor's Degree	255 (79.40)	29 (9.00)	37 (11.50)^{A}	
	Diploma	368 (70.90)	58 (11.20)	93 (17.90)^{AB}	
Age Group N (%)	21-30	464 (71.70)	70 (10.80)	113 (17.50)	$^{\#}$0.001; 0.007
	31-40	178 (84.00)	18 (8.50)	16 (7.50)^{C}	
	41-50	38 (95.00)	0 (0.00)	2 (5.00)^{C}	
Experience N (%)	1-10 years	549 (73.40)	74 (9.90)	125 (16.70)	$^{\#}$0.014; 0.010
	11-20 years	89 (85.60)	12 (11.50)	3 (2.90)^{D}	
	21-30 years	40 (95.20)	0 (0.00)	2 (4.80)^{D}	
Should clinical research be included in nursing education					
Gender N (%)	Male	256 (82.80)	19 (6.10)	34 (11.00)	*0.035
	Female	462 (76.10)	74 (12.20)	71 (11.70)	
Participated in the trial N (%)	Yes	99 (88.40)	3 (2.70)	10 (8.90)	*0.010
	No	619 (11.80)	90 (11.20)	95 (77.00)	
Organization	Government	249 (92.60)	7 (2.60)	13 (4.80)	*<0.001
	Private	469 (72.50)	86 (13.30)	92 (14.20)	
Qualification N (%)	Master's Degree	70 (92.10)	1 (1.30)	5 (6.60)	$^{\#}$<0.001; <0.001
	Bachelor's Degree	262 (81.60)	28 (8.70)	31 (9.70)^{A}	
	Diploma	386 (74.40)	64 (12.30)	69 (13.30)^{A}	
Age Group N (%)	21-30	485 (75.00)	75 (11.60)	87 (13.40)	$^{\#}$0.013; 0.049
	31-40	180 (84.90)	16 (7.50)	16 (7.50)^{C}	
	41-50	37 (92.50)	2 (5.00)	1 (2.50)^{C}	

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Experience N (%)	1-10 years	565 (75.50)	84 (11.20)	99 (13.20)	#<0.001
	11-20 years	96 (92.30)	5 (4.80)	3 (2.90) ^{D}	
	21-30 years	38 (90.50)	2 (4.80)	2 (4.80)	

**Mann Whitney U Test; # Kruskal Wallis Test; ^{A} significant difference vs master degree; ^{B} significant difference vs bachelor degree; ^{C} significant difference vs age group 21-30 years; ^{D} significant difference vs experience 1-10 years.*

17.3.4 Negative Attitude Subscale

Female nurses exhibited a higher negative attitude toward clinical trial processes like randomization, and placebo and they had a stronger belief that patients may be harmed due to trial drugs' unknown adverse effects (Table 5). Whereas the male nurses showed a more negative attitude towards additional workload by participating in a clinical trial (Table 6). They also had more concerns regarding the ability of the doctors to handle the trial drugs' adverse effects and they feared that trial drugs adverse effects will be worse than routine treatment.

Out of the 10 statements, only 3 statements showed significant association with the nurses who had participated in the clinical research. Nurses who had previously participated in clinical trials reported a significantly higher percentage of "agree" regarding additional workload due to participation in a trial and that patients will have to undergo additional medical procedures due to participation in a trial. Whereas nurses who had not previously participated exhibited more concerns that clinical research can cause harm to the patients.The nurses working in private hospitals showed more concern about patients being in the placebo group, clinical research may cause harm to the patients, randomization and trial subjects being treated as guinea pigs. Whereas nurses working in government hospitals had higher concerns regarding their additional workload due to participation in a trial, an additional medical procedure which trial patients may have to undergo and the ability of the doctor to manage trial drugs' adverse effects.The age of the nurses was significantly associated with the negative attitude of the nurses. Younger nurses were more concerned about placebo and randomization processes and other study design components. Whereas the older nurses exhibited a more negative attitude towards the practical aspects of the trial. Nurses belonging to the age group 41-50 years showed concerns about additional workload due to participation in clinical trials, additional medical procedures which trial patients may undergo, trial drug adverse effects and the ability of the doctor to manage adverse effects due trial drug. The influence of the work experience of the nurses was similar to the influence exerted by the age of the nurses. Nurses with less experience were more concerned about randomization, blinding and placebo. Whereas nurses with more experience were concerned about the additional workload due to participation in a trial, additional medical procedures which trial patients may need to undergo, the ability of the doctors to deal with trial drug adverse effects and adverse effects caused by trial drugs may be more harmful than drugs administered in routine.

The educational qualifications of the nurses also significantly influenced their attitude. Nurses with master's qualifications exhibited more negative attitudes towards additional workload due to participation in trials, additional medical procedures which trial patients may need to undergo and adverse effects caused by trial drugs may be more harmful than drugs administered in routine. Nurses with diplomas and bachelor's degrees were more concerned about the trial patients being treated as guinea pigs, about blinding and randomization. Whereas nurses with master's qualifications were more concerned about additional workload due to participation in a trial, additional medical procedures which trial patients may need to undergo and adverse effects caused by trial drugs may be more harmful than drugs administered in routine.

Table 5: Factors influencing concerns about design of clinical research

Categories	**Sub Categories**	**Agree/ (Score-3)**	**Neutral/ (Score-2)**	**Disagree/ (Score-1)**	**p Value**
Patients may be harmed as a result of the trial's unknown side effects					
Gender N (%)	Male	142 (46.00)	60 (19.40)	107 (34.60)	*0.044
	Female	311 (51.20)	131 (21.60)	165 (27.20)	
Age Group N (%)	21-30	323 (49.90)	129 (19.90)	195 (30.10)	#0.021; 0.005
	31-40	111 (52.40)	51 (24.10)	50 (23.60)	
	41-50	12 (30.00)	7 (17.50)	21 (52.50) CE	
In the placebo group, the patient's condition may be worse					
Gender N (%)	Male	109 (35.30)	53 (17.20)	147 (47.60)	*0.013
	Female	241 (39.70)	143 (23.60)	223 (36.70)	

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Organization N (%)	Government	59 (21.90)	76 (28.30)	134 (49.80)	*<0.001
	Private	291 (45.00)	120 (18.50)	236 (36.50)	
Age Group N (%)	21-30	266 (41.10)	145 (22.40)	236 (36.50)	#<0.001; <0.001; 0.001
	31-40	75 (35.40)	44 (20.80)	93 (43.90) ^{C}	
	41-50	5 (12.50)	4 (10.00)	31 (77.50) ^{CE}	
Experience N (%)	1-10 years	304 (40.60)	169 (22.60)	275 (36.80)	#0.015; 0.001
	11-20 years	30 (28.80)	19 (18.30)	55 (52.90) ^{D}	
	21-30 years	9 (21.40)	4 (9.50)	29 (69.00) ^{D}	
Clinical research is a type of experimental treatment that can cause harm to patients					
Participated in trial N (%)	Yes	38 (33.90)	29 (25.90)	45 (40.20)	*0.039
	No	373 (46.40)	153 (19.00)	278 (34.60)	
Organization N (%)	Government	96 (35.70)	64 (23.80)	109 (40.50)	*0.001
	Private	315 (48.70)	118 (18.20)	214 (33.10)	
You may feel anxious when patients are in double-blind trials because you don't know what drug they will get					
Gender N (%)	Male	113 (36.60)	67 (21.70)	129 (41.70)	*<0.001
	Female	306 (50.40)	108 (17.80)	193 (31.80)	
Organization N (%)	Government	92 (34.20)	47 (17.50)	130 (48.30)	*<0.001
	Private	327 (50.50)	128 (19.80)	192 (29.70)	
Experience N (%)	1-10 years	357 (47.70)	146 (19.50)	245 (32.80)	#0.012; 0.008;
	11-20 years	35 (33.70)	18 (17.30)	51 (49.00) ^{D}	
	21-30 years	13 (31.00)	6 (14.30)	23 (54.80) ^{D}	

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Age Group N (%)	21-30	322 (49.80)	125 (19.30)	200 (30.90)	#0.008; 0.003
	31-40	80 (37.70)	44 (20.80)	88 (41.50)[C]	
	41-50	12 (30.00)	3 (7.50)	25 (62.50)[C]	
Patients participating in clinical trials may be treated as guinea pigs					
Organization N (%)	Government	62 (23.00)	54 (20.10)	153 (56.90)	*<0.001
	Private	284 (43.90)	126 (19.50)	237 (36.60)	
Education N (%)	Master's Degree	13 (17.10)	15 (19.70)	48 (63.20)	#0.024; 0.001
	Bachelor's Degree	98 (30.50)	74 (23.10)	149 (46.40)[A]	
	Diploma	235 (45.30)	91 (17.50)	193 (37.20)[A]	
Age Group N (%)	21-30	258 (39.90)	142 (21.90)	247 (38.20)	#0.001; 0.004
	31-40	73 (34.40)	33 (15.60)	106 (50.00)[C]	
	41-50	9 (22.50)	3 (7.50)	28 (70.00)[C]	

**Mann Whitney U Test; # Kruskal Wallis Test; [A] significant difference vs master degree; [C] significant difference vs age group 21-30 years; [D] significant difference vs experience 1-10 years; [E]significant difference vs.age group 31-40 years*

Table 6: Attitude of nurses towards practical aspects of clinical research

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Clinical research will have an impact on your daily care and add to your workload					
Gender N (%)	Male	232 (75.10)	33 (10.70)	44 (14.20)	*0.003
	Female	395 (65.10)	96 (15.80)	116 (19.10)	
Participated in trial N (%)	Yes	90 (80.40)	9 (8.00)	13 (11.60)	*0.005
	No	537 (66.80)	120 (14.90)	147 (18.30)	

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Organization N (%)	Government	222 (82.50)	15 (5.60)	32 (11.90)	*<0.001
	Private	405 (62.60)	114 (17.60)	128 (19.80)	
Age Group N (%)	21-30	416 (64.30)	104 (16.10)	127 (19.60)	$^{\#}$0.000; 0.054
	31-40	162 (76.41)	22 (10.38)	28 (13.21) ^{C}	
	41-50	34 (85.00)	2 (5.00)	4 (10.00) ^{C}	
Education N (%)	Master's Degree	64 (84.20)	9 (11.80)	3 (3.90)	$^{\#}$0.013; 0.002
	Bachelor's Degree	221 (68.80)	41 (12.80)	59 (18.40) ^{A}	
	Diploma	342 (65.90)	79 (15.20)	98 (18.90) ^{A}	
Experience N (%)	1-10 years	495 (66.20)	117 (15.60)	136 (18.20)	$^{\#}$0.020
	11-20 years	85 (81.70)	6 (5.80)	13 (12.50) ^{D}	
	21-30 years	36 (81.82)	2 (4.54)	4 (9.09)	
As part of the trial process, patients may be required to undergo additional biopsies, scans, blood tests, and other procedures, which may interfere with their daily routine and quality of life					
Gender N (%)	Male	226 (73.10)	33 (10.70)	50 (16.20)	*0.004
	Female	382 (62.90)	102 (16.80)	123 (20.30)	
Participated in trial N (%)	Yes	86 (76.80)	14 (12.50)	12 (10.70)	*0.009
	No	522 (64.90)	121 (15.00)	161 (20.00)	
Organization N (%)	Government	221 (82.20)	24 (8.90)	24 (8.90)	*<0.001
	Private	387 (59.80)	111 (17.20)	149 (23.00)	
Education N (%)	Master's Degree	62 (81.60)	7 (9.20)	7 (9.20)	$^{\#}$0.049; 0.006
	Bachelor's Degree	216 (67.30)	45 (14.00)	60 (18.70) ^{A}	
	Diploma	330 (63.60)	83 (16.00)	106 (20.40) ^{A}	

Categories	Sub Categories	Agree/ (Score-3)	Neutral/ (Score-2)	Disagree/ (Score-1)	p Value
Age Group N (%)	21-30	390 (60.30)	113 (17.50)	144 (22.30)	$^{\#}$0.000; 0.000
	31-40	171 (80.70)	18 (8.50)	23 (10.80) ^{C}	
	41-50	34 (85.00)	3 (7.50)	3 (7.50) ^{C}	
Experience N (%)	1-10 years	473 (63.20)	121 (6.20)	154 (20.60) ^{D}	$^{\#}$0.010; 0.000
	11-20 years	91 (87.50)	5 (4.80)	8 (7.70)	
	21-30 years	33 (78.60)	3 (7.10)	6 (14.30)	

*Mann Whitney U Test; $^{\#}$ Kruskal Wallis Test; ^{A} significant difference vs master degree; ^{C} significant difference vs age group 21-30 years; ^{D} significant difference vs experience 1-10 years

17.4 Discussion

In the current study factors exerting significant influence on the attitude of the nurses were analysed. The overall mean score on the positive attitude subscale was 25.47 depicting a high positive attitude but the score on the negative subscale was also high. A high score on the negative subscale indicates that there were certain aspects of clinical research and participation of nurses in clinical trials about which nurses had negative beliefs. Similar findings were shown in the study by Kao *et al.* (2019) that ward-based nurses working in a hospital in Taiwan had limited knowledge about clinical research and showed negative beliefs about certain aspects of clinical research.

In our study majority of the nurses had not previously participated in clinical trials. The gender-wise analysis of the positive attitude showed that male nurses had a higher score on the positive subscale in comparison to female nurses. This indicated that male nurses had a more positive attitude in comparison to female nurses. The study by Nkrumah *et al.* (2018) also showed that male nurses working in hospitals in Ghana used clinical research in their practice more than female nurses. The authors also reported that despite having a positive attitude, a very less (12.22%) number of nurses had previously participated in any clinical research. Our results showed that nurses who had previously participated in clinical research and who were working in government hospitals had a more positive attitude. The study by Devrani *et al.* (2018) showed similar findings that despite having a favourable attitude towards research, very few nurses participated in research activities. Another study also reported that nurses who had previously participated in clinical trials had higher knowledge and a more positive attitude towards clinical research (Bulut Aksoy *et al.*, 2018).

The nurses working in government hospitals exhibited higher positive attitude scores in comparison to the nurses working in private hospitals. The probable reason for this observation could be that the majority of the government hospitals were research organizations. Therefore, they had more exposure to the clinical research field. The data analysis also showed that the experience of government hospital nurses was more as compared to the others. The level of positive attitude towards clinical research among the participating nurses was also influenced by their overall job experience. With more experience, the level of positive belief was raised. Hanibernia (2018) also reported that nurses who were having more experience displayed more knowledge and positive attitude about the basics of clinical research. The educational backgrounds of the participating nurses also had a substantial impact on the proportion of positive attitudes and accurate responses. Nurses with a master's degree showed more positive belief towards clinical research followed by those with a bachelor's and a diploma. A previous study also reported that nurses with master's qualifications were most inclined towards clinical research followed by nurses with bachelor's degrees and diplomas (Nkrumah *et al.*, 2018).

The negative attitude statements could be divided into two broad categories. The first category statements were about the basic study design elements of the trial and the second category comprised statements regarding practical aspects of the trials. It was observed that younger nurses with less experience and lower educational qualifications were more concerned about the basic design elements such as randomization, placebo and blinding whereas older nurses with more experience and higher qualifications were more concerned about their additional workload due to participation in trial and trial drugs unknown adverse effects. Younger nurses with less experience and diploma qualification have limited exposure to clinical research and clinical trial which leads to certain negative beliefs about clinical trials. Studies previously conducted reported that lack of knowledge was the major barrier towards the attitude of nurses towards clinical research. A study reported that a positive correlation existed between the knowledge level of the nurses and positive attitudes towards clinical research (Bulut Aksoy *et al.*, 2018). Another study by Salberg *et al.* (2022) exploring the role of oncology nurses in clinical trials concluded that educational interventions are required for the nurses to bridge the knowledge gaps and improve the nurses' competencies in engaging patients in clinical trials. The study by Margevicius *et al.* (2021) concluded that online educational intervention improves the knowledge and attitude of nurses towards clinical research. The educational intervention further improved the intention of the nurses to engage patients in clinical trials. Another negative belief of the nurses was that participating in a clinical trial accounted for additional workload. Lack of dedicated time for clinical research has been previously reported as one of the barriers to the motivation of nurses towards clinical research (Akerjordet, Lode and Severinsson 2012). In our study, older nurses and nurses with more experience were more concerned about the additional workload in comparison to younger nurses with less experience. A study conducted on nurses working in endoscopy laboratories and surgery units also showed that older nurses with more experience were less interested in clinical research and were of the view that clinical research is not important (Jacobson *et al.*, 2008).

17.5 Conclusion

It is concluded that participants showed a positive attitude towards the role of clinical research in the advancement of medicine and the advantages of clinical research. Limited experience in a clinical trial contributed towards certain negative beliefs. However, nurses agreed that clinical research has the potential to increase the nursing profession. So, clinical research education must be effectively included in the nursing curriculum. The knowledge of the nurses must be improved to stay up with the expanding clinical research market in India. To improve their clinical research knowledge and skill set, specialized training programs and ongoing medical education are necessary.

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18

Bridging Ancient Wisdom and Modern Medicine: Herbal Mediated Nanoparticles in Biomedical Applications

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18.1 Introduction

The ability of plants to create medicinal compounds is a natural God's gift. Some medicinal plants have been utilized as herbal medicine since ancient times due to their therapeutic properties (Ali, 2020). Man has been looking for cures for a variety of illnesses since ancient times. Man has historically looked to nature for two main needs: food for survival and medicinal herbs for illnesses and pains (Srivastava, 2018). Various plants and herbs were widely employed as remedies in prehistoric human civilization since it was a rudimentary idea to discover the medicinal ability of plants (Kalita *et al.,* 2018).

The production of the economically valuable medications was based on the natural products of both traditional and modern medicinal plants (Subhose *et al.,* 2005). Antibacterial, antimicrobial, antiviral, antioxidant and as well as antifungal qualities with little or no harmful effects were found in different secondary compounds, essential oil & plant extract. These properties are crucial for the treatment of different illnesses (Hassan and Ullah, 2019). They are present in significant amounts in seeds, cereals, whole grains, nuts and vegetables (sweet potato, kale, cauliflower, carrot, cabbage, cooked tomato, bean, soybean), fruits (citrus fruit peel, grapes, oranges, cherries, berries, apricots, apples) and green tea. Numerous phytochemicals strengthen the immune system and shield the body from harmful infections (Khan*et al.,* 2019). These naturally occurring substances derived from plants can be isolated from several types of plants parts, consisting of roots, fruits, leaves, seeds, rhizomes, barks, stems, flowers etc., demonstrating that these physiologically active substances are present in every single part of the plant.

World Health Organization (WHO) reports that, 80% of people all throughout the world rely on traditional medicine, and medicinal plants are the best source of pharmaceuticals (Mahato *et al.,* 2018). Earlier North African, Chinese, and Indian civilizations recognized the therapeutic value of certain plants in treating a range of illnesses (Cowan, 1999).In the field of medicine, plants are crucial since they are the largest source of novel, highly effective medications and therapies as well as natural chemicals with therapeutic value. The global market for herbal medicines is anticipated to increase to around $39.6 billion in 2022 from $29.4 billion in 2017, according to BBC Research (Stan *et al.,* 2021).

Due to a lack of medical professionals, inadequate medical facilities, and a scarcity of medications, herbal medications made from medicinal plants have gained significant attention recently because of their antimalarial, antibacterial, pain-relieving, antipyretic, anti-inflammatory, anticancer, antifungal, cytotoxic, and antiviral properties. The phytochemicals found in medicinal plants are what give them their therapeutic qualities (Piero *et al.,* 2012). Phytochemicals are naturally occurring, physiologically active chemical substances that are present in plants & that serve as nutrient & medicinal elements that are good for human health. According to crucial role in the metabolism of plants, phytonutrient possess historically been categorized like main or specialized metabolites. Amino acids, purines, proteins and pyrimidines of a polynucleotide, common sugars, chlorophylls, and other substances are examples of central metabolites. Glucosides, saponins, flavonoids, steroids, curcumines, terpenes, lignans, phenolics, and alkaloids are examples of secondary metabolites (Koche *et al.,* 2016).

Plant-based antimicrobials are more successful than manufactured medications, which have numerous adverse effects, for treating infectious disorders. Plant secondary metabolites like polyphenols have antibacterial qualities that protect against harmful and spoiling microorganisms, among other advantages. It has been demonstrated that these compounds' varying chemical compositions result in variations in their antibacterial activity (lateif *et al.,* 2016).

Resistance to antibiotic has emerged due to the extensive, inappropriate, erratic and careless uses of antibiotics, making many commonly prescribed drugs ineffective (Baym *et al.,* 2016). According to the WHO, this recent development is concerning & might be the most urgent issue facing the medical science (WHO accessed on 14 august 2021). As a result, the need to develop new antimicrobial agents that can prevent the development of antibiotics resistance and lower antibiotic use is increasing.

By inhibiting the growth of bacteria, fungus, viruses, and protozoa through different mechanisms than currently employed antimicrobials, medicinal plant antimicrobial substances may have substantial clinical utility in treating resistant microbial strains (Shankar *et al.,* 2010). Numerous chemicals that have antimicrobial, antioxidative, anti-bacterial, and antiviral properties were found through phytochemical research. These substances included spermidine, rutin, quercetin, tocopherol, and carotenoids (Tlili *et al.,* 2011).

18.2 Antimicrobial Potential of Medicinal Plants

Gram-negative (*Escherichia coli and S. gallinarum*) & gram-positive (*S. uberis* & *S. aureus*) strains of bacteria were tested for antimicrobial characterstics of "carqueja" (*Baccharis trimera*) decoction, and it was discovered that the former are more susceptible to this herb than the latter.

Extract of *Vernonia polyanthes* exhibits powerful inhibiting action contrary to*Leishmania* strains. Additionally, it was noted that *B. subtilis, B. cereus, S. aureus*&*Pseudomonas aeruginosa*were suppressed in their growth by the artichokes (*Cynara scolymus*) aqueous extract & both "macela" (*Achyrocline satureioides*) and artichokes ethanol extracts (80%) (Avancini *et al.,* 2000).

Research regarding the antimicrobial activity usage the leaves of natural plants such as *P. guajava* ("guava"), *Syzygium aromaticum* (clove), *Cymbopogon citratus* (lemongrass), *Mentha piperita* (peppermint), *A. sativum* (garlic), *Baccharis trimera* ("carqueja"), *Zingiber officinale* (ginger) and *Mikania glomerata* ("guaco") of 70% methanol extracts revealed action takenin opposition to*S. aureus*.The extract that performed the best were guava 0.56 mg/mL and clove 0.36 mg/mL (Betoni *et al.,* 2006).

Acetone, hexane, methanol, ethanol, chloroform & aqueous extracts of*Lippia alba* roots and leaves were tested for their antimicrobial properties against *B. subtilis, P. aeruginosa, Micrococcus luteus, Serratia marcescens, E. faecalis, E. coli, Candida albicans, Monilia sitophila, S.*

aureus and *Mycobacterium smegmatis,* at an intensity of 2 mg/disc. The findings showed that while methanol, hexane& ethanol derivatives from leaves inhibited the development of B. subtilis, S. aureus, M. smegmatis, M. sitophila, C. albicans & M. luteus, chloroform, acetone& ethanol extracts from roots did the same(Aguiar *et al.,* 2008).

Essential oils derived from theleaves of *Croton zehntneri* known as wild cinnamon were tested for their ability to inhibit strains of *Salmonella Typhimurium, Shigella flexneri, E. coli, Streptococcus β-hemolyticus* and *S. aureus*. They were found to have antimicrobial activity against all bacteria except *Salmonella*, and to have a highly significant inhibitory effect on *S. flexneri* at 25 μg/mL(Costa *et al.,* 2008).

Highest inhibitory zone on *Candida albicans* was shown within curry leaves that are alcoholic, which were then tea leaves in water. To a lesser degree, the development of *Candida albicans* was also suppressed by various plant extracts, such as alcoholic aloe vera, alcoholic leaves of tea, and leaves of alcoholic mint, alcoholic onion leaves and onion bulbs alcoholic (Sunitha *et al.,* 2013).

Leaves of *Azadirachta Indica* extracted using chloroform, hexane and methanol tested against *Proteus vulgaris, Escherichia, Enterococcus faecalis, Klebsiella pneumonia* and *Micrococcus luteus.* While chloroform extract was found to have moderate to good antibacterial activity, methanol extract was reported to exhibit the greatest. Bacillus subtilis was shown to be more resistant to the neem extracts in methanol, hexane, and chloroform, whilst Proteus vulgaris and Micrococcus luteus were the most vulnerable bacteria (Koona and Budida, 2011).

Aqueous, ethanolic & methanolic Extract of *Jatropha Curcas* stem bark tested against *Escherichia coli, Shigella dysenteriae, Staphylococcus aureus, Klebsiella pneumonia and Pseudomonas aeruginosa*. For several organisms, ethanol extract's MIC varied from 0.5 to 6.25 mgml-1, whereas the methanol extract's ranged from 0.5 to 10 mgml-1(Igbinosa *et al.,* 2009).

Lantana Indica leaves extracted with ethyl acetate, water & methanol tested in opposition to*Steptococcus pyrogens, Bacillus subtilis, Pseudomonas aeruginosa, Klebsiella pneumoniae, Staphylococcus aureus, Salmonella typhi,, Candida albicans*and *Aspergillus niger.* According to reports, ethyl acetate extract of the leaves shown moderate efficacy against the tested bacteria, while the methanol and aqueous extracts demonstrated significant activity (Venkataswamy *et al.,* 2010).

Betula Utilis bark extracted with chloroform, water, petroleum ether, ethanol and methanol by using diffusion technique in an agar well.The typical medication was Gentamicin 10mcg/disc (5 mm in diameter). *Proteus mirabilis, Salmonella typhimurium, Klebsiella pneumonia, Shigella* *flexneri, Staphylococcus aureus* and *Shigella boydii* used as test organisms. All of the studied bacteria were shown to be significantly inhibited by methanol extract, which was followed by ethanol and aqueous extract. Chloroform and petroleum ether extract showed no action (Kumaraswamy *et al.,* 2008).

18.3 Green Nanoparticles

Plant extract used to create nanoparticles might be the most effective technique since they can generate faster, more economical & more effective nanoparticles. Harvesting plants is simple and widely distributed throughout habitats (Srikar *et al.,* 2016).

They have a quantity of chemical constituents that is capable of taking the place of chemical reducing agents like sodium borohydride, sodium citrate and corbate are expensive dangerous and harmful to the environment (Ahmed *et al.,* 2016).In fact, several investigations have demonstrated that chemical constituents found in plant extracts, such as polysaccharides, phenolic acids, quercetins & flavonoids is capable of efficiently reducing metal ions such as Au3+, Ag+ and Cu2+. Additionally, they can perform a variety of chelating, stabilizing, and capping tasks when nanoparticles are forming. (Jadoun *et al.,* 2021).

Green nanoparticles' tiny size, large surface area, high biocompatibility, stability, adaptability, and many other exceptional qualities make them ideal for a variety of medicinal applications, comprising the handling of different illness& antibacterial, antifungal, and anti-cancer characterstics. Compared to alternative biological approaches, using plant extracts to synthesis nanoparticles offers greater efficiency, ease of handling, safety, and speed. Plant parts such as stems, flowers, latex, seeds, peel, leaves, bark and roots are typically used to extract phytochemicals (Rafique *et al.,* 2017).

Nanoparticles are prepared using a variety of techniques, including chemical, biological, and physical processes. The chemical vapor deposition, hydrothermal method, pyrolysis, micelle, sol process & chemical precipitation are examples of physical or chemical procedures that are typically used to create nanomaterials.

The traditional processes used to produce NPs are costly, hazardous, and not environmental friendly. Researchers have discovered the exact green routes—that is, naturally existing sources and their byproducts—that may be utilized for the synthesis of nanoparticles in order to get around these issues (Rafique *et al.,* 2019).

18.4 Role of Phytochemicals for Nanoparticle Biosynthesis

Phytochemical substances found in plant extracts serve as organic stabilizers in nature or reductant throuhout the formation of nanoparticles. Numerous active phytochemicals, including polyphenols (flavonoids, lignans, phenolic acids and tannins), proteins, glycosides, triterpenoids, polysaccharides, organic acids, reducing sugars, fatty acids, steroids, triterpenoidal saponins and alkaloids are found in plant extracts (Zuhrotun *et al.,* 2023). The adsorptive, biological, catalytic and biocompatible qualities of nanoparticles can all be enhanced by the inclusion of phytochemicals derived from plant extract. The phytochemicals enhance the surface of nanoparticles for the adsorptive activity by adding additional functional groups. As a result, they increase physicochemical interactions and surface functionalization (Nguyen*et al.,* 2022). According to published research, the primary reducing and stabilizers utilized within the production of nanoparticles are proteins, reducing sugars, and polyphenol chemicals (Zuhrotun *et al.,* 2020).

18.5 Mechanisms for Nanoparticles Synthesis Using Plant Extract

The bioreduction of plant-derived proteins is the general process used to create nanoparticles of Pt, Ag & Au nanoparticles from an extracts of plant. Functional groups like carbonyl, hydroxyl, and amine are frequently found in plant extracts. These groups react with metal ions to form variously shaped and sized nanoparticles.

According to Zheng 2013, a number of variables, including temperature, reducing sugars, and flavonoid concentrations, affected decrease of Pt(II) into nanoparticles of Pt(0). Plant extracts also show a potential method by which the decrease & stability of the conversion of ($AuCl4-$) chloroaurate ions to gold nanoparticles, according to another study (Huang *et al.,* 2011).

The reduction of Ag+ to Ag0 may have been facilitated by some molecules containing terpenoids, protein, flavonoids, sugars, or other bioactive chemicals (Borase *et al.,* 2014).

18.6 Applications of Plant Derived Nanoparticles

Nanotechnology can significantly increase the oral bioavailability of medications by reformulating them with smaller particle sizes. As a result, it can replace numerous traditional oral formulations that are unsuccessful due to their low bioavailability as a therapeutic option. Green synthetic methods have been developed to produce using microorganisms, plants and other natural resources to create nanoparticles in response on the rising need for nanotechnology and green chemistry. Potential applications for these green nanoparticles derived from plants possess optics, biotechnology, electronics, sensors, agriculture, imaging, medicine, cosmetics, dye degradation, water purification, food packaging, engineering textile & bioengineering sciences (Trivedi *et al.*, 2022).

The antibacterial activity of metallic nanoparticles has been shown to be very effective (Singh *et al.*, 2020). In order to overcome their resistance, the nanoparticles increase the stress on bacterial cells by concurrently targeting many biomolecules in the bacterium.

Both caspase-mediated and reactive oxygen species-dependent apoptosis in cancer cell lines may be the cause of metallic nanoparticles' conceivable antitumor action. The manufacture of magnesium oxide putchuk root extract nanoparticles for breast cancer cell lines resistance (MCF-7) was the main focus of author. (Amina and Guo, 2020). The findings indicate that cancer cells of 67.3% were eliminated, suggesting the produced magnesium oxide tiny particles might make a substantial contribution to the area of cancer treatment.

Ag and Au nanoparticles were created using *S. nodiflora* leaf extract in order to carry out antifungal activities. Consequently, Ag nanoparticles' inhibition zone against *Aspergillus* and *Penicillium* species was around 12.9 mm and 10.9 mm, correspondingly. Au nanoparticles exhibit a reduced inhibition of zone (~9 mm) regarding both *Penicillium*&*Aspergillus* species under the identical circumstances (Vijayan *et al.*, 2018).

18.7 Conclusion

Plants are a cheap, easily scalable, and ecologically safe way to create silver nanoparticles. It is particularly well-suited for creating nanoparticles that, in order to be used in therapeutic applications, must be free of harmful contaminants. The plant based synthesis offers numerous advantages over conventional methods of synthesis. It might serve as a good alternative to treat different pathogenic diseases caused by resistant microbes.

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19

The Role of Traditional Herbal Medicines in the Treatment of Polycystic Ovary Disorder

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19.1 Introduction

The term "polycystic ovary syndrome" (PCOS/PCOD) refers to a condition where a woman's hormones are out of balance, which can lead to irregular periods and difficulty getting pregnant. If left untreated, PCOS can eventually cause major health issues like diabetes and heart disease. The majority of women with PCOS develop numerous tiny cysts on their ovaries, which is why the condition is called that. It is one of the most common endocrine disorders affecting women worldwide who are of reproductive age (Azziz *et al.,* 2016). PCOS symptoms include oligomenorrhea, amenorrhea, acne, hirsutism, dysfunctional uterine hemorrhage, obesity, and other major symptoms. PCOS is considered to be one of the main causes of female subfertility and pregnancy problems. PCOD is linked to metabolic abnormalities such as insulin resistance, dyslipidemia, and an elevated risk of type 2 diabetes in addition to reproductive health issues (Nandi *et al.,* 2020). The ovary does not produce all the hormones required for an egg to fully mature in women with PCOS Syndrome. The follicles may begin to grow and accumulate fluid, but ovulation does not occur; instead, some follicles may remain as cysts. As a result, progesterone is not produced, causing a woman's menstrual cycle to be absent or irregular. Additionally, male hormones produced by the ovaries also prevent ovulation (Wardhan, 2016).

Anti-androgens, insulin-sensitizing medications, and hormonal contraceptives are commonly used in the traditional medical treatment of PCOD. These methods, however, frequently treat symptoms rather than underlying reasons, and they may have negative effects if used for an extended period of time (Teede *et al.*, 2018). As a result, traditional herbal remedies are becoming more and more popular as alternative or supplementary therapies.

Herbal treatments for gynecological problems have been used for ages in traditional medical systems such as Traditional Chinese Medicine (TCM), Ayurveda, and diverse indigenous healing methods. Instead of focusing on specific symptoms, these methods frequently seek to bring the body's systems back into balance (Arentz *et al.*, 2017). The scientific data demonstrating the effectiveness of important herbal remedies in the treatment of PCOD is examined in this article.

19.2 Causes of PCOD

- **Raised LH secretion:** In the early follicular stage, the normal level of LH hormone is 2–8 IU/L, and in the mid-cycle peak, it is 10-75 IU/L. However, insulin induces an increase in LH secretion, which leads to infertility and miscarriage due to poor oocyte maturation.
- **Hyperandrogenism:** It causes a decrease in hepatic sex hormone binding globin (SHBG), which raises free testosterone levels and causes hirsuitism. Additionally, androgens inhibit the growth of dominant follicles.
- **Obesity:** Obesity is associated to PCOD. Obesity is common in around 60–70% of PCOD patients. Adipose tissue, or fat, is regarded as an endocrine and immunomodulatory organ. It secretes proteins called cytokines and hormones like adinopectin and leptin that disrupt the liver's and muscles' insulin transduction pathways, leading to insulin resistance and hyperinsulinemia.
- **Genetics:** Certain genes, such as CYP18, CYP19, and CYP21, exhibit changed expression, indicating that the genetic abnormality in PCOD impacts signal transduction pathways that regulate the action of steroid hormones, gonadotropins, steroidogenesis, insulin, chronic inflammation, energy homeostasis, and other processes (Chandak, 2022).

19.3 Pathophysiology of PCOD

One of the main components of PCOS is ovarian pathology (Ibáñez *et al.*, 2017). From a pool of primordial follicles that have been in the ovaries since birth, a single follicle grows and passes through ovulation in a typical viable female. To preserve ovarian reserve and guarantee fertility, the rate at which primordial follicles are chosen for growth is closely regulated (Hsueh *et al.,* 2015).Follicle growth is stopped in PCOS due to an imbalance between androgens, follicle stimulating hormone (FSH), and anti-Müllerian hormone (AMH) (Franks *et al.,* 2008). Ovarian granulosa cells produce AMH, which plays a crucial role in stopping primordial follicles from developing into primary follicles. Numerous primordial follicles that mature and then experience growth arrest are the cause of the ovaries' distinctive polycystic appearance in PCOS (Ibáñez *et al.,* 2017). The production of androgen by ovarian theca cells depends on elevated levels of luteinizing hormone (LH). Due to the lack of a dominant follicle, anovulation is caused by high LH, low FSH, and decreased oestradiol production by androgen conversion. An additional significant element of PCOS is insulin resistance (IR). Insufficient tissue use of insulin for glucose metabolism leads to IR. IR in PCOS is thought to be caused by genetic, intrauterine, and extrauterine factors as well as responses to the consumption of high-energy foods, while the precise mechanisms are still unknown. It is also believed that IR and hyperinsulinemia are significantly impacted by puberty. There may be a brief rise in insulin levels and IR during puberty. More amino acids are accessible for growth when insulin-like growth factor-1 (IGF-1) and growth hormone levels rise. Protein metabolism is unaffected by IR throughout puberty, however only glucose metabolism is (Saenger, 2000).Adipose tissue, skeletal muscles, and the liver are all impacted by IR in PCOS. Nonetheless, the adrenal glands and steroidogenic ovaries continue to be responsive to insulin's effects. Insulin also has the effect of reducing the liver's production of sex hormone binding globulin (SHBG), which raises the levels of free androgens. Regardless of their degrees of "adiposity" or androgen concentrations, women with PCOS frequently have increased serum insulin and IR (Dunaif *et al.,* 1992).

19.4 Conventional Treatment of PCOD

Anti-androgens, insulin-sensitizing drugs, and combined oral contraceptive pills (COCPs) are the main pharmaceutical treatments for PCOD today. Each of these treatments has unique efficacy profiles and possible side effects.

- **Metformin**: The most often given insulin sensitizer, metformin, increases ovulation rates and insulin sensitivity, but in around 25% of cases, it produces gastrointestinal problems such nausea, diarrhea, and stomach pain (Teede *et al.,* 2018).

- **COCPs:**Although COCPs, which combine ethinylestradiol with progestins such as drospirenone or cyproterone acetate, efficiently control menstrual periods and lower hyperandrogenism, they may also worsen insulin resistance and raise the risk of thromboembolism (Legro *et al.,* 2017).
- **Thiazolidinediones:** Although pioglitazone and other thiazolidinediones are effective in increasing insulin sensitivity, several risk factors like fluid retention, weight gain, and possible cardiovascular risks have been associated with their use (Salomäki *et al.,* 2014).
- **Anti-androgens:** Anti-androgens like spironolactone work well for hirsutism and acne, but they need to be used with contraception since they may cause electrolyte abnormalities, especially hyperkalemia, and fetal feminization risks (Moreno *et al.,* 2020).
- **Newer agents:** Although they are still expensive and have frequent side effects including nausea and an increased risk of pancreatitis, newer medications, such as GLP-1 receptor agonists, appears promising in treating the metabolic components of PCOD (Tanday *et al.,* 2022).

19.5 Traditional Herbal Medicines in the Treatment of PCOD

Because of their multi-targeted strategy and typically positive safety ratings, traditional herbal medications present intriguing possibilities for the management of PCOD. These herbal remedies may offer all-encompassing management options that address the hormonal and metabolic components of PCOD when combined with lifestyle changes and traditional therapies when required. Herbs that are frequently used to treat or manage PCOD include:

Spearmint (*Mentha spicata*)

Due to its anti-androgenic qualities, spearmint tea has been used for a long time. Women with PCOD who consumed spearmint tea for 30 days saw a significant decrease in free testosterone levels and an improvement in hirsutism scores, according to a controlled trial performed by Grant (2018). Inhibiting the action of the 5α-reductase enzyme, which changes testosterone into the more potent dihydrotestosterone (DHT), is the suggested method. High levels of phenolic chemicals, especially rosmarinic acid and flavonoids, are found in spearmint according to biochemical study; these compounds may be responsible for the plant's ability to modulate hormones (Akdoğan *et al.,* 2019). These substances might also have antioxidant properties, which would help with the oxidative stress that is frequently seen in PCOD.

Cinnamon (*Cinnamomum verum*)

Cinnamon has emerged as a promising natural therapy for PCOD because to its insulin-sensitizing characteristics. According to a study conducted by Wang *et al.* (2021), women with PCOD who took 1.5g of cinnamon supplements daily for 12 weeks experienced notable changes in menstrual cyclicity and insulin sensitivity when compared to a placebo. It has been demonstrated that the active ingredients in cinnamon, especially methylhydroxychalcone polymer (MHCP), improve glucose absorption and insulin receptor phosphorylation (Jamilian *et al.,* 2020). Furthermore, cinnamon has anti-inflammatory qualities that could aid in treating the persistent low-grade inflammation that PCOD patients frequently experience. According to a study carried out by Li *et al.* (2019), women with PCOD who took supplements of cinnamon saw moderate but steady decreases in inflammatory indicators including C-reactive protein.

Chasteberry (*Vitex agnus-castus*)

In addition to its long history of treating female reproductive diseases, chasteberry has demonstrated promise in the treatment of PCOD symptoms. Women who took 20 mg of chasteberry extract daily for three months saw improvements in menstrual regularity and decreases in prolactin levels, according to a clinical investigation by Shahnazi *et al.* (2020). The herb helps to normalize gonadotropin release and enhance ovarian function by acting on the hypothalamic-pituitary axis, namely on dopamine receptors. Chasteberry may also alter the function of the estrogen and progesterone receptors, which could help with the hormonal imbalances that PCOD is known for (Zamani *et al.,* 2019). It is especially important for women with PCOD who want to recover ovulatory function because of its effects on luteinizing hormone (LH) and follicle-stimulating hormone (FSH) ratios.

Fenugreek (*Trigonella foenum-graecum*)

Compounds in fenugreek seeds have anti-androgenic and insulin-sensitizing qualities. According to a randomized controlled research by Swaroop *et al.* (2020), women with PCOD who took 500 mg of fenugreek seed extract for three months saw notable improvements in insulin sensitivity, decreased cyst size, and menstrual cyclicity. It has been demonstrated that the active ingredients in fenugreek, especially diosgenin and 4-hydroxyisoleucine, improve insulin signaling and glucose absorption while also adjusting sex hormone binding globulin (SHBG) levels (Rajan *et al.*, 2022). Both the hormonal and metabolic components of PCOD may be addressed by this dual approach.

Ashwagandha (*Withania somnifera*)

Because of its effects on endocrine function and stress response, this adaptogenic herb from Ayurvedic medicine has showed promise in the treatment of PCOD. Ashwagandha's capacity to regulate the hypothalamic-pituitary-adrenal (HPA) axis may have indirect advantages, as stress is known to exacerbate PCOD symptoms (Chandrashekhar *et al.*, 2021). As per the study conducted by Rehman *et al.* (2023), women with PCOD who took 300 mg of ashwagandha root extract for eight weeks shown significant improvements in insulin sensitivity, decreased psychological distress, and decreased cortisol levels when compared to a placebo. Ashwagandha may also enhance ovarian function and help return gonadotropin levels to normal.

Berberine-containing Herbs

Chinese goldthread (*Coptis chinensis*) and goldenseal (*Hydrastis canadensis*) are two herbs that contain the alkaloid berberine, which has demonstrated exceptional promise in treating various PCOD symptoms. In women with PCOD, berberine supplementation improved insulin resistance, decreased testosterone levels, and stimulated ovulation, according to a study by Heidari *et al.* (2022). Its effectiveness was similar to that of the standard drug metformin, although it had less gastrointestinal side effects. Berberine mechanistically stimulates AMP-activated protein kinase (AMPK), a crucial modulator of cellular energy homeostasis. This leads to decreased hepatic glucose synthesis and enhanced peripheral tissue insulin sensitivity (Zhang *et al.*, 2021). Berberine also seems to alter the growth of ovarian follicles and suppress the synthesis of androgen by theca cells.

19.6 Integration of Herbal Remedies with Conventional Treatment

Integrative treatment, which combines evidence-based herbal remedies with suitable conventional treatments, seems to be the most promising strategy for managing PCOD. The cornerstone of any PCOD treatment strategy continues to be lifestyle changes, such as dietary adjustments and consistent exercise (Teede *et al.*, 2018).

Practitioners should assess possible herb-drug interactions when contemplating herbal remedies, especially with insulin-sensitizing drugs and hormonal contraceptives. The use of herbal medications into customized treatment programs should be guided by patient preferences, the severity of symptoms, and treatment objectives.

19.7 Limitations and Future Perspectives

There are a number of restrictions on the present research on herbal remedies for PCOD, despite encouraging findings. Numerous studies have short durations, small sample sizes, and inconsistent methodological quality. Because different products have different amounts of active compounds, standardizing herbal medicines is still difficult.

Future study should focus on larger, long-term clinical trials with standardized herbal preparations. Investigating the synergistic effects of combining numerous plants, as is frequent in traditional medical systems, may reveal significant information. The potential of herbal therapies to address the underlying pathophysiology of PCOD may also be shown by investigating their epigenetic effects.

19.8 Conclusion

There is evidence to support the effectiveness of traditional herbal remedies in treating many facets of PCOD, making them promising supplementary ways to managing this complicated condition. For women with PCOD, cinnamon, spearmint, chasteberries, fenugreek, ashwagandha, and herbs containing berberine have shown promise in enhancing insulin sensitivity, hormonal balance, monthly regularity, and general quality of life.

The most thorough management plan would be an integrative one that incorporates evidence-based herbal remedies, lifestyle changes, and traditional medicines where needed. Healthcare professionals should stay up to date on the possible advantages and drawbacks of using herbal remedies to treat PCOD as research in this area develops so they can help patients make evidence-based decisions regarding their care.

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20

Bridging Tradition and Science: The Impact of Ancient Ayurvedic Texts on Modern Pharmacology and Herbal Remedies

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20.1 Introduction

Ayurveda, a term derived from the Sanskrit words "ayus" (life) and "ban" (knowledge), is an old medicine system that originated in the Indian subcontinent more than 3,000 years ago. It is one of the oldest holistic healing systems in the world and encompasses a knowledge spectrum that integrates the physical, mental and spiritual dimensions of health. The historical roots of Ayurveda date back to the Vedic texts, particularly the Atharva Veda, where it is recognized not only as a healing system but as a philosophy that covers all aspects of life, emphasizing the balance within environment, body, and mind (Hazari, 2023). The fundamental aspects of Ayurveda are encapsulated in their concepts of the three two: Vata, Pitta and Kapha, which is believed to govern physiological and psychological functions. The unique constitution of each individual, or prakriti, determines the susceptibility to diseases and describes the way to achieve optimal health through personalized diet, lifestyle and herbal interventions.

Ayurveda's relevance in ancient Indian medical practices stands out for its comprehensive approach to health management, in which it emphasizes preventive care through modifications of lifestyle and the use of natural remedies derived from plants, minerals and animal products (Sahay, 2023). These remedies were meticulously documented in ancient texts, including the Charaka Samhita and Sushruta Samhita, which systematically detailed therapeutic procedures, surgical techniques and pharmacological formulations. These texts served not only as instruction manuals for professionals, but also contributed significantly to the cultural heritage of medical knowledge in ancient India. The ethical imperative of Ayurvedic practice is based on the principle of promoting individual well -being and harmony through the use of the natural world, thus establishing a holistic paradigm that contrasts with the most reductionist medical approaches.

While the integration of ayurveda into modern pharmacology presents opportunities, it is not exempt from challenges. Standardization -related problems, dose, quality control and security require careful consideration to ensure that Ayurvedic remedies can be integrated without compromising their effectiveness. The establishment of clear protocols for research and application is essential to validate these traditional remedies within a scientific framework. Both Mukharji (2020) and Dal Lin *et al.* (2020) ask for an open dialogue between traditional professionals and the scientific community to address these problems, emphasizing the importance of mutual respect and understanding.

In addition, the acceptance of the Ayurvedic principles within the institutional health environments marks a significant evolution in the perception of complementary medicine in the global health paradigm. As more doctors are educated in integrating approaches, the potential of combined therapies based on the increases of Ayurvedic and pharmacological foundations, racing the way for a more holistic understanding of health and disease management. This integration means a notable step towards a more complete health model that values a variety of therapeutic modalities. The integration of Ayurvedic practices and plant remedies in contemporary pharmacology occurs in a complex regulatory framework which varies considerably from one jurisdiction to another. As Mukherjee *et al* pointed out. (2019), regulatory organizations are often faced with the challenge of reconciling old medicine systems with modern scientific standards. This can lead to both opportunities and obstacles for the recognition and acceptance of Ayurvedic remedies in global health systems.

In countries like India, Ayurveda is recognized as a legitimate medical system, governed by specific Ayurvedic acts which provide a legal structure for the practice and promotion of Ayurvedic drugs. The Ayush Ministry was created in 2014 to improve the focus on traditional systems, including Ayurveda, Unani, Siddha and Homeopathy. However, the regulatory framework often does not have the rigorous standards mandated for allopathic medicine, including directives for clinical trials and efficiency assessments. Consequently, many Ayurvedic drugs remain on the market without complete scientific validation, thus raising questions about their safety and efficiency.

On a global scale, the acceptance of Ayurvedic practices remains fragmented. Regulatory organizations such as the European Medicines Agency (EMA) and the US Food and Drug Administration (FDA) generally require robust clinical evidence for the approval of conventional pharmaceuticals, while traditional drugs and Ayurveda often do not have the infrastructure for complete clinical trials that meet these strict criteria. This regulatory difference has notable difficulties; Ayurvedic formulations can face skepticism in medical contexts based on evidence, thus limiting their integration into traditional health care.

In addition, the potential for poor communication occurs with regard to definitions of terms such as "natural" and "traditional" drugs. Like the Rammanohar articula (2019), traditional knowledge systems such as Ayurveda often count on holistic approaches that fundamentally diverge from the dominant reductionist model in Western pharmacology. Non -linear and multiple facets of Ayurvedic therapies complicate the establishment of standardized dosages and treatment protocols, which are characteristic of a prerequisite for conventional drug approval processes. This is where a central challenge lies: how is the effectiveness of Ayurvedic remedies, often informed by centuries of empirical practice, supported in a frame designed for pharmaceutical products?

Issueof intellectual property rights and biopiracia has important regulatory challenges. We fear that Western pharmaceutical companies can exploit fundamental indigenous knowledge of Ayurveda without providing appropriate recognition or compensation to communities of origin. This ethical dilemma not only complicates cross -border collaborations, but also has risks for the sustainability of traditional knowledge systems and biodiversity.

Like Mukherjee *et al.* (2019) suggest that regulatory harmonization can provide ways to fill these shortcomings, but the realization of consensus poses significant challenges. The diversity of Ayurvedic practices in different regions, associated with inadequate data on pharmacokinetics and pharmacodynamics of plant remedies, further complicates standardization and regulatory compliance efforts. Researchers and regulatory organizations are therefore called upon to engage in dialogue, focusing on methodologies that respect the principles of Ayurveda and modern science. Collaboration efforts are necessary to develop executives that can assess the effectiveness of Ayurvedic treatments in a responsible manner, concluding a balance between tradition and innovation.

20.2 Impact of Different Kind of Herbal Remedies

Ayurveda's continuous importance is manifested in its ability to influence contemporary pharmacology, where modern scientists increasingly explore the effectiveness of specific herbal remedies referred to in ancient texts. This exploration occurs in a context of a growing demand for natural and integrative health solutions against modern health challenges. In particular, many Ayurvedic herbs, such as Ashwagandha (*Withania somnifera*) and turmeric (*Curcuma longa*), have gained recognition for their therapeutic potential, with an investigation that validates their antioxidant, anti-inflammatory and adaptain properties. Studies have shown that active components within these plants are not only aligned with the therapeutic statements made in ancient texts, but also exhibit mechanisms of action that are often congruent with the principles established in pharmacology (Hazari, 2023 and Sahay, 2023).

Charaka Samhita, attributed to Salvia Charaka, is perhaps the oldest complete treaty on the Ayurveda, dating back to about 400 BC. This fundamental work systematically classifies various herbs and their therapeutic properties, underlining the importance of balanced the three dosha i.e. Vata, Pitta and Kapha as a milestone of health (Sharma *et al.,* 2021). Charaka methodologies extend beyond the simple prescription of the remedies. It processes the principles of the maintenance of health and the prevention of diseases, laying the foundations for a preventive approach that resonates with modern health paradigms. For example, the use of turmeric (*Turmeric longa*), widely documented in Charaka's Samhita for its anti-inflammatory properties, has found validation in contemporary studies, which corroborate its effectiveness in modulating inflammatory responses and its antioxidant spectrum capabilities.

In the same way, Sushruta Samhita, attributed to Sushruta, is mainly focused on surgical procedures but contains priceless intuitions concerning the herbal formulations and their applications in pre-operational and post-operational treatments. This text also highlights various vegetable -based anesthetic and antiseptic, with specific compounds such as Vacha (Acorus Calamus) which is mentioned for their neuroprotective and analgesic properties (Kurhekar, 2021). The principles clarified in the work of Sushruta extend to modern pharmacology, in particular in understanding the pharmacokinetics and pharmacodynamics of herbal agents. The textual emphasis on the systematic evaluation of these substances, including the dosage and the method of administration, has a surprising similarity with contemporary practices in pharmacological studies.

In addition, Sharma *et al.* (2021) and Kurhekar (2021) strengthen the idea that empirical knowledge documented in these ancient texts constitutes an essential reference point for modern clinical research. Since pharmaceutical research is increasingly aimed at natural products for new therapeutic agents, the detailed descriptions of herbal compounds in these texts provide crucial data that can facilitate bioprospection and development of drugs. If combined with contemporary methodologies such as controlled randomized studies, the remedies based on herbs documented in the Samhitas of Charaka and Sushruta are subject to a rigorous scientific validation, opening the way for their integration into medicine based on evidence.

In addition, the role of nature in Ayurvedic healing practices highlights the cultural reverence of medicinal plants and their natural properties. Ayurveda encourages the use of herbal remedies that are considered extensions of the healing capacities of the Earth; a feeling resonated in the findings of Mathpati *et al.* (2020). These authors emphasize that contemporary pharmacology can benefit from returning to this root philosophy, which advocates the use of natural substances that promote physiological harmony and support the innate healing processes of the body. Recognize the intrinsic qualities and interactions of the plant with the human body align with the modern pharmacological understanding of pharmacodynamics and pharmacokinetics, which seek to elucidate how the compounds affect biological systems.

The integration of Ayurvedic concepts into contemporary pharmacology is evident in the scientific validation of certain herbal remedies, such as Ashwagandha (*Withania somnifera*) and turmeric (*Curcuma longa*). The investigation has highlighted the adaptive properties of Ashwagandha, supporting the ayurvedic claim of its effectiveness in the management of stress and anxiety by restoring the balance in the responses of the body to environmental pressures (Teppone, 2019). Meanwhile, the active compound of turmeric, curcumin, has been widely studied by its anti -inflammatory and antioxidant properties, which show how ancient Ayurvedic recipes are aligned with a rigorous scientific research. Mathpati *et al.* (2020) additionally analyse several studies that provide empirical evidence of the biological activity of these herbs, closing the gap between traditional knowledge and modern therapeutic applications.

In general, the philosophical foundations of Ayurveda, which emphasize the dynamic interaction between the body, the mind and nature, serve not only as a governing principle for herbal medicine but also as a framework to understand contemporary biomedical research.

This synthesis of ancient wisdom and modern scientific validation encourages a more holistic approach to medical care, encouraging professionals and researchers to explore the potential of Ayurvedic practices within the modern medical framework. Such approach honors Ayurveda's original intention while committing to the advances and methodologies prevalent in contemporary pharmacology. Ayurveda, with its tradition of healing of millennia, provides a vast repository of remedies based on plants noted for their therapeutic potential. Among the herbs cited in ancient texts, Ashwagandha (*Withania somnifera*) and Turmeric (*Turmeric longa*) are distinguished because of their in-depth use and their growing scientific validation in contemporary medicine.

Ashwagandha, often called "Indian ginseng", has been used in Ayurvedic medicine for its adaptogenic properties, which would improve the body's resilience to stress and the promotion of global vitality. Traditional texts such as Charaka Samhita and Sushruta Samhita emphasize the role of grass in the toning of the nervous system and the improvement of vitality, especially among those who are old or in weakened state (Qadir and Raja, 2021). Recent studies corroborate these claims, revealing that Ashwagandha not only has adaptogenic effects but also anti-inflammatory, antioxidant and neuroprotective properties. A systematic review carried out by WeGeser *et al.* (2020) Detailed How Ashwagandha extract considerably reduces cortisol levels, indicating its effectiveness in stress management. In addition, the potential of grass to improve cognitive function and memory has been demonstrated in randomized controlled trials, positioning Ashwagandha as a precious candidate in the field of modern pharmacology (Mukherjee *et al.,* 2019).

Turmeric, in particular its bioactive compound curcumin, has been well documented in Ayurveda for centuries, in particular with regard to its anti-inflammatory and antioxidant properties. Sushruta Samhita highlights the application of turmeric in the management of various diseases, including skin disorders, digestive problems and inflammatory conditions (Qadir and Raja, 2021). Modern pharmacological research has started to confirm these ancient affirmations, because significant attention has turned into curcumin in recent decades. For example, a meta-analysis of Hewlings and Kalman (2017) has examined many preclinical and clinical trials that illustrate the role of curcumin in the modulation of inflammatory pathways, with effects comparable to those of non-steroidal anti-inflammatory drugs (NSAID). In addition, the evidence suggests that curcumin can play a role in the management of chronic conditions such as arthritis and cardiovascular disease, promoting the relevance of grass in contemporary therapeutic contexts (Mukherjee *et al.,* 2019).

Ashwagandha and turmeric illustrate the intersection of ancient practices and a modern scientific survey, presenting how traditional remedies based on Ayurvedic plants provide a basis for contemporary pharmacological research. The scientific validation process is not only used to elucidate action mechanisms, but also to offer an overview of potential therapeutic applications that align with the current challenges of health care. While researchers continue to explore these ancient plants based on plants, it becomes more and more obvious that wisdom anchored in Ayurvedic texts serves as a precious asset in the design of contemporary treatment methods.

The continuous integration of herbs like Ashwagandha and turmeric into modern pharmacology is an example of the way in which traditional medicine informs and enriches current therapeutic practices. By punching ancient wisdom with modern scientific methodologies, a more in-depth understanding of remedies based on plants emerges, highlighting their multiple facets advantages and strengthening the need for continuous exploration of these ancient texts in contemporary health paradigms., Recent scientific consultations have tried to corroborate the effectiveness of herbal remedies described in the old Ayurvedic texts, using rigorous methodologies to investigate their pharmacological properties. An outstanding example is the study by Verma *et al.* (2024), which systematically evaluated the therapeutic potential of *Curcuma longa* (turmeric) in various inflammatory conditions. The researchers used double-blind random controlled trials to evaluate the anti -inflammatory effects of curcumin, the main bioactive compound in turmeric. Their findings revealed significant reductions in inflammatory markers such as C-reactive protein (CRP) and Interleucin-6 (IL-6) among participants administered by curcumin extracts, which provides empirical support to its historical use in Ayurveda to treat inflammation.

In a complementary vein, Giannenas *et al.* (2020) investigated the pharmacological properties of *Withania somnifera* (Ashwagandha), another widely documented herb in Ayurvedic literature. His clinical trials focused on Ashwagandha's adaptogenic effects on stress and anxiety. The study showed that participants who received Ashwagandha extract exhibited decreased anxiety levels measured by standardized anxiety scales, along with improvements in sleep quality and stress resistance. Such results corroborate the traditional indications of Ashwagandha as a mild sedative and rejuvenating tonic, as referenced in Ayurvedic texts.

In addition, the examination of the antimicrobial properties of *Tinospora cordifolia* (Giloy) further illustrates the intersection of

Ayurveda and contemporary pharmacology. The research has shown that Giloy's extracts have significant antibacterial and antiviral activity, which support their use as an immunomodulatory agent in Ayurvedic medicine. In a series of in vitro experiments cited by Verma *et al.* (2024), Giloy's extracts demonstrated an effective inhibition of gram-positive and gram-negative bacterial strains, which supports its application in infection management.

The validation of these herbal remedies is aligned with a broader trend in pharmacology to integrate traditional knowledge with scientific research. The systematic review of Giannenas *et al.* (2020) emphasizes the importance of using standardized formulations in clinical research to evaluate the reliability of historical claims. Through their investigation of Ayurvedic formulations that contain multiple herbs, the researchers determined that these combinations often produce synergistic effects not observed in studies of a single wound, highlighting the need for holistic approaches both in research and in clinical practice.

In addition, the principles of Ayurveda encourage a multifaceted understanding of health, which can enrich the predominantly reductionist approach to modern pharmacology. This integrative perspective causes a change towards the exploration of the synergistic effects within the herbal combinations, as seen in formulations such as Triphala, which includes three fruits: Amalaki (*Emblica officinalis*), Bibhitaki (*Termia bellirica*) and Haritaki (*Terminal chebula*). The research has indicated that the combined effects of these ingredients can improve bioavailability and efficiency, thus offering a robust alternative to isolated compounds within the development of contemporary drugs (Mukharji, 2020).

20.3 Impact of Formulations

One of the promising avenues for innovation is in the formulation of new drug therapies derived from ayurvedic herbs. Many of these remedies, which have been employed for centuries, contain bioactive compounds that can serve as lead in the discovery of medicines. For example, compounds extracted from ayurvedic herbs, such as *Curcuma longa* (turmeric) and *Withania somnifera* (Ashwagandha), attracted considerable attention for their anti-inflammatory and adaptogenic properties, respectively. The scientific validation of these plant-based remedies was substantiated through several pharmacological studies that demonstrated their effectiveness and bioactivity, further filling the gap between old practices and modern pharmacology (Semwal *et al.*, 2019). The potential of these plant-based extracts to act as models for synthetic analogue design can lead to innovative therapies directed to contemporary health problems, including chronic inflammatory diseases and mental health disorders.Recent academic advances have facilitated collaboration efforts among traditional practitioners, pharmacologists and clinical researchers. Dal Lin *et al.* (2020) demonstrate this integration through an exhaustive review of clinical trials that investigate the effectiveness of Ayurvedic formulations. Its analysis highlights not only the therapeutic potential of these formulations in the management of chronic diseases such as diabetes and arthritis, but also underlines the need for rigorous methodologies that can confirm and quantify these effects. For example, studies that evaluate bioactive compounds in turmeric, particularly curcumin, have shown promising results in the modulation of inflammatory paths, which echoes ayurvedic statements with respect to its effectiveness in the mitigating conditions derived from excessive inflammation.

Ayurveda's ancient texts often refer to powerful herbal remedies, but do not constantly provide sufficient information on doses, formulation and possible adverse effects. This gap can complicate the integration of these remedies into contemporary pharmacology, particularly as health professionals seek to use traditional herbal solutions along with modern therapeutic modalities. The existing literature reflects these concerns, especially Rammanohar (2019), who clarifies that certain Ayurvedic formulations can contain heavy metals and other toxic substances, mainly as a result of traditional preparation methods. For example, the inclusion of lead, mercury and arsenic in some formulations for therapeutic utility increases alarms with respect to patient safety, especially in terms of accumulated toxicity on prolonged use.

In addition, Buragohain *et al.* (2024) highlight the importance of the rigorous scientific validation of Ayurvedic practices, advocating well-designed clinical studies to determine the safety profiles of these herbal remedies. His research indicates that, although some Ayurvedic herbs exhibit promising pharmacological effects, they often house a spectrum of bioactive phytochemicals whose interactions and potential toxicity remain little known. Specifically, the variability in the quality of raw herbal materials can lead to inconsistent responses of patients, presenting challenges for standardization and regulation. Pharmacovigilance in Ayurvedic medicine is critically underdeveloped, demanding the implementation of integral security monitoring frameworks to address the adverse events associated with herbal therapies.

In addition, the concept of "rasa", or pleasure, in Ayurveda is directly correlated with the understanding of safety and toxicity, since it is believed that certain tastes indicate the nature of the effects of the grass on the body. Excessive consumption of herbs labeled as "ushna" (heating) can lead to side effects such as gastrointestinal disorders or inflammatory conditions, which raises a challenge for patient management. The complexity of Ayurvedic formulations, often that comprise multiple herbs in synergistic combinations, complicates the determination of security profiles, since interactions can improve or mitigate toxic effects. Therefore, improved research is justified aimed at elucidating these multifaceted interactions.

20.4 Ayurveda Futures Prospective

In addition, Ayurveda's future in pharmacology is likely to be driven by advances in analytical techniques that facilitate the identification of active compounds and their mechanisms of action. The rise of technologies such as high performance screening, metabolomic and genomic studies presents a significant opportunity to decode the complex phytochemical of ayurvedic drugs. A systematic approach to understanding the typical Ayurveda polyherbal formulations may allow researchers to isolate synergistic effects, which are usually present in traditional remedies, but absent from isolated compounds used in contemporary pharmacological research (Talukdar *et al.,* 2024). Such insights provide a more different understanding of how these compounds can be integrated with clinical applications, potentially increasing effectiveness and minimizing adverse effects.

In addition, the preservation of traditional ayurvedic knowledge is critical to ensuring that invaluable ideas and practices are not lost to modern industrialization and marketing of health care. As highlighted by Semwal *et al.* (2019), there is an urgent need for collaborative partnerships between traditional ayurvedic professionals and modern scientists to create a deaphane exchange of knowledge. This collaboration can facilitate the development of evidence -based practices that honor Ayurveda's therapeutic principles, ensuring rigorous scientific scrutiny, enriching the pharmacological scenario.

Future implication for Ayurveda on pharmacological innovation also resonate in the context of global health trends, as society increasingly values more natural and sustainable sources of medicine, in contrast to synthetic pharmaceutical products. With increasing concerns around antibiotic resistance and the sustainability of current drug manufacturing processes, returning to nature for solutions has a pragmatic path to face these challenges. Initiatives that promote ethical supply, biodiversity conservation, and community cultivation of medicinal plants are crucial to not only to preserve traditional knowledge, but also to ensure the long -term viability of ayurvedic practices in contemporary medical contexts.

In short, the intersection of ayurvedic principles and modern pharmacological research has fertile ground for discovery, innovation and sustainability. As the scientific community increasingly values the importance of integrating traditional knowledge systems in modern health care, ayurvedic texts can serve as guesting beacons that illuminate the way towards a more holistic and patient-centered approach to pharmacology, promoting pharmacotherapeutic advances that resonate with the rigorous ancient scientific rigor and contemporary scientific rigor., The exploitation of ancient ayurvedic texts reveals a deep legacy that significantly influenced contemporary pharmacology, offering a robust structure to understand plant -based medicines that continue to resonate in modern medicinal practices. The Ayurvedic System, with its holistic health and disease approach, emphasizes the balance of body systems and the use of natural substances to promote to be good. As shown by Mathpati *et al.* (2020), the intricate knowledge contained in these texts on the therapeutic properties of various herbs found validation in contemporary scientific investigations, elucidating their action mechanisms and confirming their effectiveness in treating a variety of diseases.

The resurgence of interest in herbal medicine has led to strict scientific evaluations of traditional ayurvedic medicines, filling the gap between ancient wisdom and contemporary practices based on evidence. Shankar (2021) illustrates as specific herbs, such as Ashwagandha (*Withania somnifera*) and turmeric (*Curcuma long*), underwent extensive research to substantiate their therapeutic claims. Ashwagandha, traditionally used as an adaptogen and neuroprotective agent, has been validated through modern clinical studies, demonstrating its role in reducing stress and increasing cognitive function. Likewise, curcumin, the active compound in saffron, attracted attention for its powerful anti-inflammatory and antioxidant properties, supported by a growing body of clinical evidence that subsides its application in chronic disease management.

In addition, the approach to standardization and quality control of herbal formulations, inspired by practices described in ayurvedic texts, became fundamental in contemporary pharmacology. The integration of ayurvedic principles with modern pharmaceutical practices promotes a broader understanding of plant -based drugs, ensuring their safety and effectiveness for clinical use. The adaptability of ancient Ayurvedic concepts such as the emphasis on individualized treatment regimens provides a valuable perspective that is increasingly relevant in personalized medicine.

20.5 Conclusion

In conclusion the discussion surrounding Charaka Samhita and Sushruta Samhita underlines the lasting stay of the ancient Ayurvedic texts. Their contributions to the understanding and application of herbal remedies continue to model contemporary drug practices, demonstrating the importance of interdisciplinary dialogue between traditional knowledge and modern scientific investigation. This synergy not only improves the therapeutic landscape, but also reaffirms the holistic principles that are the basis of well -being and healing in various cultural contexts., Ayurveda's philosophical foundations are deeply interwoven with their health and healing approach, emphasizing the principle of balance between the three twos: vata, pitta and kapha. Each dosha represents a combination of the five elements (earth, water, fire, air, space) that govern the physiological and psychological processes. As Teppone (2019) is articulated, the Ayurvedic paradigm postulates that optimal health arises from maintaining the balance between these doshas, which is crucial not only for individual well -being but also for harmonious interaction with the natural environment. This holistic perspective extends to the understanding that health is not simply the absence of diseases, but a sustained state of physical, mental and spiritual balance that is inextricably linked to nature and its rhythms.

The integration of Ayurvedic remedies in modern medical care requires a conscious approach to toxicity and safety. Rigorous scientific exploration is essential to validate therapeutic aspects while guaranteeing that practices do not compromise patient safety. The voices of Rammanohar (2019) and Baragohain *et al.* (2024) Articulate a critical need for more complete studies to balance the ancient wisdom of Ayurveda with contemporary care standards, thus ensuring that security concerns are not only recognized but are fully approached in the search for effective and holistic treatment options., As the field of pharmacology continues to evolve, the integration of ancient Ayurvedic wisdom presents opportunities and challenges for the future of drug discovery and therapeutic development. The complex understanding of human health and disease incorporated into ayurvedic texts offers a unique perspective that contrasts with predominantly reductionist biomedical approaches. As articulated by Talukdar *et al.* (2024), the resurgence of interest in holistic and integrative medicine requires a more collaborative structure, where traditional knowledge systems such as Ayurveda can coexist alongside modern scientific paradigms.

In the light of the successful synthesis of ancient knowledge and contemporary research methodologies, it is essential to defend continuous exploitation and the validation of ayurvedic practices within the domain of modern pharmacology. This not only honors the historical significance of these traditions, but also opens avenues for new therapeutic discoveries that can improve health results. The continuous interdisciplinary research that encompasses ayurvedic scholars and pharmacological scientists is crucial to further substantiate the therapeutic potential of these plantsbased drugs, ensuring that the wisdom of ancient texts continues to inform and influence modern medical practices. This collaborative approach, as highlighted by Mathpati *et al.* (2020) and Shankar (2021) can defend the legitimacy of traditional medicine in the constantly evolving scenario of health, promoting a more integrated system that respects the contributions of ancient and contemporary medical paradigms.

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21

From Ayurveda to Innovation: The Evolution of Drug Formulation and Preparation in India

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21.1 Introduction

The historical trajectory of pharmaceutical development in India reveals a profound tradition of herbal medicine that has significantly influenced contemporary practices (Mukherjee *et al.,* 2019). The traditional Indian medicinal systems, mainly Ayurveda, Siddha and Unani, laid the foundations for understanding the therapeutic properties of various plants and their extracts, which were documented in ancient texts such as Charaka Samhita and Sushruta Samhita. These texts not only encapsulated herbs-based formulations, but also underlined the holistic approach to health, integrating physical, mental and spiritual well-being.

The meaning of these traditional practices cannot be overrated, as they have provided a base for pharmacognosy, the study of medicinal drugs derived from plants or other natural sources. The meticulous methodologies adopted for the preparation of drugs, including extraction, purification and formulation processes, show an early understanding of chemistry and biochemistry. For example, the preparation of "Rasayana" and "Kshara" exemplifies sophisticated approaches to the formulation of drugs that persisted over the centuries, illustrating the continuity of the transmission and adaptation of knowledge in response to evolving health needs.

Historical milestones, such as the establishment of indigenous pharmaceutical companies, in the 19th and early twentieth century, marked the transition from traditional to systematic formulation. The advent of the colonial era introduced western scientific methods to India, leading to the synthesis of new drugs and the globalization of the pharmaceutical landscape. However, despite these influences, Indian pharmaceutical companies have maintained a focus on herbs and vegetable medicines, which were more accessible and culturally acceptable to a significant part of the population.

While we passed at the end of the twentieth century, the liberalization of the Indian economy and the emergence of a pharmaceutical sector led by knowledge catalyzed rapid progress. The integration of traditional knowledge with modern technologies, such as biotechnology and pharmacogenomic, has allowed Indian researchers to explore new therapeutic paths while maintaining the fundamental principles of traditional medicine (Kumar *et al.,* 2020). This synergy has led to the development of Polyherbal formulations that combine multiple plants to improve therapeutic efficacy by minimizing the side effects, thus reflecting the holistic nature of traditional practices.

In addition, the recognition of the World Organization of Traditional Medicine for achieving better health results has aroused renewed interest and investments in this sector. The establishment of the Ayush Ministry (Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy) underlines the commitment of the Indian government in the integration of traditional practices in the public health framework, promoting the research and standardization of herbal medicines to face the challenges of contemporary health.

The reverberations of these historical and traditional practices continue to resonate in the contemporary pharmaceutical industry of India. The ongoing research aimed to validate the effectiveness and safety of traditional formulations aligns with global tendencies towards personalized medicine and natural alternatives to synthetic drugs. As such, the rich inheritance of India in drug formulation does not only serve as a testimony of its cultural heritage, but also as a vital resource for innovative pharmaceutical developments that meet modern health needs. This evolving landscape places opportunities to exploit traditional knowledge in synergy with scientific progress, potentially opening the way to India to remain on the front line in holistic health solutions in a quickly evolving global environment.

The interaction between traditional practices and modern pharmacology has not only enriched the pharmaceutical landscape, but has also led to innovative studies of synthesis and bioavailability of plants based on plants. Contemporary research is increasingly focusing on the validation of traditional formulations through empirical evidence, thus improving their acceptability on the world market. The world change towards phytopharmaceuticals and natural products has reaffirmed the importance of traditional knowledge systems, allowing India to position itself strategically in the global field of health care.

The evolution of the formulation and the preparation of drugs in India dates back to old medicine systems, including Ayurveda and Siddha, which not only provided fundamental principles for pharmacology but also influenced contemporary practices. These traditional systems are codified in ancient texts that have guided the preparation and administration of plant remedies for centuries, with an impressive understanding of medicinal plants and their potential therapeutics.

The growing global demand for plant -based products has a myriad of possibilities for Indian companies. The rise in electronic commerce and online health markets has enabled consumers around the world to access plant -based products. This accessibility is associated with an increasing trend towards natural lifestyles, which are perceived as safer and more in line with personal health philosophies. Efforts to develop quality insurance protocols and regulatory frameworks for plants based on plants are essential to guarantee that exported products meet international safety and efficiency standards, thus improving consumer confidence (Khan and Ahmad, 2019).

In addition, educational institutions and research organizations in India are increasingly focusing on phytochemistry, pharmacognosia and biotechnological aspects of traditional drugs. This paradigm change towards the integration of modern scientific validation into historical practices could strengthen international market confidence in Indian plant products. Collaborative companies with global pharmaceutical giants can also facilitate the exchange of knowledge and investments, which contribute to stimulating innovation in this sector.

The confluence of traditional wisdom with contemporary pharmaceutical science not only positions India as a key director of the global plant -based drug market, but also highlights the potential of a sustainable and culturally rooted approach to health care solutions. By recognizing the importance of this synergy, stakeholders in the Indian pharmaceutical industry are well placed to exploit the growing market of natural products, thus shaping the future trajectory of global health paradigms., The exploration of the formulation and the preparation of drugs in India reveals a rich tapestry of historical milestones which underline the important role of traditional practices in contemporary pharmaceutical development. Throughout history, India was at the forefront of medicinal innovation, mixing ancient wisdom with modern scientific methods. The synthesis of traditional Ayurvedic drugs, Unani and Siddha not only provides an overview of indigenous healing practices, but also a deep influence on the continuous evolution of the formulation of drugs.

Key historical milestones such as the creation of Ayurvedic texts, in particular the Charaka Samhita and Sushuta Samhita in ancient times, laid the foundations of medicine based on plants and surgical techniques that were ahead of their time. These texts highlighted the importance of holistic approaches and the integration of various natural substances that have been used in the formulation of drugs, subsequently influencing traditional and modern practices. Commitment with these historical texts promotes a sophisticated understanding of pharmacognosy and chemistry, which is essential in the development of contemporary pharmaceutical products(Mukherjee *et al.,* 2021).

In addition, the British colonial era witnessed an increased interest in traditional medical systems from India, leading to the formalization and normalization of practices that had been mainly oral. The recognition of these practices has stimulated the creation of institutions dedicated to research and the application of traditional remedies, sowing seeds for a more systematic approach in the formulation of drugs. The post-independence era has catalyzed the progress of the formulation of drugs, as the government highlighted the self-sufficiency and the local production of pharmaceutical products, paving the way to a robust pharmaceutical industry.One of the main challenges is the lack of uniformity in the supply of plant materials. India, with its vast biodiversity, supports a plethora of plant -based resources. However, this great variation considerably complicates normalization processes. Traditional practices are often based on local knowledge systems, which are not necessarily aligned with contemporary methods of scientific validation. These practices may not explain factors such as climatic variations, soil conditions and other ecological influences which can affect phytochemical composition (Mukherjee *et al.,* 2021). Consequently, the efficiency and safety profiles of plant -based products may vary considerably, which has led to challenges in the creation of coherent therapeutic results.

Quality control measures in the plant -based drug sector also suffer from insufficient regulatory frameworks. Traditionally, plants based on plants in India were governed mainly by secular practices and the subjective expertise of practitioners. The modern regulatory environment evolves slowly; However, the implementation of strict standards that align with good international manufacturing practices (BPF) remains incoherent. Mukherjee et al. (2021) point out that the harmonization of traditional knowledge with modern scientific approaches is critical but not yet fully achieved. The absence of rigorous clinical evaluation and standardized test methods for plant -based drugs further aggravates these problems.

In response to these challenges, recent regulatory efforts aim to apply more strict guidelines for assessing the quality of plant -based products. The establishment of executives such as Ayush standards has sought to ensure the uniformity and safety of plant -based drugs, emphasizing documentation, quality control and validation protocols (Mukherjee *et al.,* 2021). These regulations emphasize the need for practices based on evidence, where plant formulations must undergo in -depth pharmacological studies to support allegations of efficiency and safety.

In addition, the rise of modern analytical techniques, such as high performance liquid chromatography (HPLC) and mass spectrometry, has significant implications for the evaluation and standardization of plant -based drugs. These methodologies allow the identification and quantification of phytonutrients and active constituents, facilitating greater consistency and reliability in medication formulations. However, the integration of these techniques put forward into traditional practices poses challenges, in particular in the context of training, infrastructure development and resource allocation (Mukherjee *et al.,* 2021).

In addition, there is an ongoing debate on intellectual property and traditional knowledge. The application of modern patents to traditional formulations raises ethical concerns concerning the marketing of indigenous knowledge. The biopiracie potential presents a risk for local communities whose traditional practices are crucial for the development of new plant -based drugs. Regulatory executives are now increasingly advocating the service sharing agreements to recognize the contributions of traditional healers and local communities in pharmaceutical progress.

21.2 Ancient History of Ayurveda

Ayurveda, one of the oldest medical systems documented in the ancient Indian texts, in particular the "Charaka Samhita" and the "Sushruta Samhita", plunges into various aspects of health, diseases and medical treatments. The Treaty of Charaka, dated approximately 100 AD, is significant for its complete approach to medicine, emphasizing the holistic treatment of individuals thanks to the use of natural substances (Adhikari and Paul, 2018). It systematically describes the therapeutic properties and applications of hundreds of plants based on plants, detailing their pharmacological effects and their appropriate preparations. This old text attaches immense importance on the role of herbs in treatment, pleading for individualized care of patients based on constitutional types (Prakriti), thus establishing a framework for personalized medicine.

Likewise, the "Sushruta Samhita", attributed to Sushruta, is particularly remarkable for its surgical techniques and the medicinal use of plants. The work of sushruta, which dates back to around 600 before JC, tackles not only surgical procedures but also provides developed descriptions of many compounds based on plants used for analgesia and anesthesia. This text serves as an early example of integration of surgical practices into pharmacological knowledge, reflecting an advanced understanding of botanical and surgical sciences in ancient India.

The SIDDHA system, mainly practiced in Tamil Nadu, is another ancient therapeutic framework which has significantly contributed to the techniques of preparing medication in India. Siddhar's tradition emphasizes an experiential understanding of medicinal plants, transmitted by oral traditions and compiled later in texts such as texts "Siddha Vaidhya". These works highlight the therapeutic use of 108 medicinal plants, documenting their preparation methods, their dosages and their specific health benefits. This system has a unique mixture of alchemy and herbarism, indicating sophisticated methods of medication formulation that preceded modern pharmaceutical developments.

One of the key stages of this period was the incorporation of western education and medical practices in the Indian health system, which was obvious from the creation of institutions such as Calcutta Medical College in 1835 and later, the All India Institute of Medical Sciences in 1956. These institutions focused on teaching western biomedicine and pharmaceutical sciences often marginalizing traditional systems such as systems like Ayurveda and Unani. The colonial government has systematically devalued indigenous medical knowledge through a combination of policies and practices, including the codification of drugs, which has led to a more standardized pharmaceutical approach that imitated Western formulations (Mukherjee, 2019).

In the 1950s, India began to formulate its pharmaceutical policies in a post-colonial context, seeking to develop its manufacturing capacities. The creation of the law on drugs and cosmetics in 1940, although prior to independence, drew renewed attention while the nation tried to regulate the quality of drugs and improve public health results (Sharma, 2019). This law has laid the foundations for a structured approach to the regulations and the formulation of drugs, opening the way to the creation of many public and private pharmaceutical companies during the decades that have followed.

The 1960s and 1970s were marked by important stages in the Indian pharmaceutical industry, in particular thanks to the initiation of state -run manufacturing programs. Recognizing the need for self -sufficiency in pharmaceutical products, the Indian government has made efforts to produce essential drugs locally. The introduction of the 1970 patent law, which effectively eliminated foreign entities from their patents on drugs, allowed Indian companies to develop and manufacture generics, further facilitating the transition of traditional systems to modern practices (Elkordy *et al.,* 2021).

The introduction of research institutions dedicated to the development of new drugs, including the Indian Medical Research Council (ICMR), created in 1911 and the Central Drug Standard Control Organization (CDSCO) formed in 1951, underlined the commitment to advance modern pharmaceutical practices. These institutions have provided the necessary framework for clinical research, quality control and creation of directives for the formulation and drug approval processes.

At the end of the 20th century, the Pharmaceutical Industry of India had increasingly adopted the progress of drug formulation technologies, including the introduction of biotechnology and more sophisticated chemical synthesis techniques. This era marked the entry into complex generics and biopharmaceuticals, which began to dominate the market, both at the national and international level. While India has established its presence as a global actor in the pharmaceutical sector, the adaptive capacity of traditional practices has served as a vital basis for this progress.

India has a richness of biodiversity, with approximately 7,500 plant species with flowers being documented for medicinal use. This rich biodiversity forms a critical reservoir for drug discovery and development. The work of organizations such as the Indian Medical Research Council (ICMR) and various universities emphasizes the hybridization of traditional practices with modern scientific methods. Systematic studies have led to the identification of numerous phytochemicals, causing a resurgence in traditional herbal formulations and their marketing, reflecting a significant bridge between historical wisdom and contemporary health paradigms.

Emerging research tools, such as high performance screening and genomic technologies, have further catalyzed the use of natural products in the development of new medicines. In recent years, collaborative efforts between traditional professionals and modern pharmacologists have gained traction, illustrating the potential to leverage local knowledge systems for the development of sustainable therapeutic solutions. This collaboration not only promotes the preservation of traditional practices, but also contributes to the economic empowerment of local communities involved in the supply and cultivation of medicinal plants.

21.3 Development Process of Ayurvedic Formulations

In Ayurveda and Siddha, the approach to the formulation of drugs was not simply based on the empirical knowledge of plants but also of the integrated aspects of philosophy, spirituality and the constitution of the human body. This holistic perspective has considerably influenced the development of contemporary drugs in India, offering a rich pharmaceutical heritage which integrates traditional wisdom into modern science. For example, various Ayurvedic formulations have been subject to scientific validation, leading to the reintroduction of natural compounds in traditional therapies (Sharma, 2019).

The key historical stages of Indian pharmacology have established an inheritance that permeates time. Practices such as the systematic classification of herbs, the detailed documentation of their medicinal properties and the preparation of formulations resonate with modern pharmacological methodologies. This historical context not only underlines the depth of indigenous knowledge in the formulation of drugs, but also highlights persistent continuity in which old traditions inform and enrich current pharmaceutical innovations. The work of Adhikari and Paul underlines that the fusion of ancient principles with contemporary techniques is essential in understanding the current position of India in global pharmaceutical developments, and the role of traditional systems remains a crucial area of exploration in the broader context of pharmacology., Traditional medication formulation practices in India are deeply rooted in a rich tapestry of cultural and medicinal knowledge, often encapsulated in systems such as Ayurveda, Siddha and Unani. These methodologies, which have been perfected over thousands of years, reflect an important aspect of India's historical relationship with health and well-being. They emphasize the holistic approaches to well-being, given not only physical illnesses but also mental and spiritual aspects of health (Sharma, 2019).

The Ayurveda plant preparation methodologies are characterized by detailed texts such as the "Charaka Samhita" and the "Sushruta Samhita", which form the foundation of plant remedies. Practitioners use a plethora of plants, each selected according to their pharmacological properties as well as the constitution of the individual, or Prakriti. For example, herbs like Ashwagandha (Withania Somnifera) and Turmeric (Turmeric Longa) are generally formulated in various preparations, including decoctions, powders and pasta, suitable for improving their efficiency and their digestibility (Anand *et al.,* 2022).

The preparation process in Ayurvedic practice is meticulous. This often involves harvesting herbs at specific times of the year when their medicinal properties are at their peak, followed by methods such as drying, grinding and combining them with other substances (Anand *et al.,* 2022). These practices guarantee not only the preservation of active compounds, but also promote synergistic effects when combined, thus improving therapeutic results. For example, the formulation of Chyawanprash, a secular rejuvenating tonic - incorporates a range of herbs as well as honey and ghee, promoting medicinal and nutritional advantages.

Siddha medicine, predominant in Southern India, uses similar methodologies but is distinguished by its use of minerals and animal products alongside herbs. For example, the preparation of "Kushtanashini", a formulation based on plants used for skin disorders, implies a complex process which includes the purification and calcination of the metals combined with ingredients based on plants. This reflects a unique approach that exploits botanical and mineral remedies to solve health problems. These traditional practices underline the localized knowledge systems which have evolved according to the regional flora and the specific health requirements which prevail in different communities (Anand *et al.,* 2022).

21.4 Role of Traditional Practices

These traditional practices have played a central role in community health. Many rural populations are based on these screen printing remedies, which are often more accessible and culturally acceptable than modern pharmaceuticals. The importance's of local healers, who know the art of plant -based medicine well, improve community confidence and promote a sense of identity linked to traditional practices. Studies indicate that these formulations based on local plants are not simply alternatives to allopathic medicine. They frequently complete existing health systems, offering preventive and curative options that resonate in cultural contexts (Anand *et al.,* 2022).

In addition, with the resurgence of interest in sustainable natural remedies and health care, traditional practices are increasingly influenced contemporary pharmaceutical developments. The integration of traditional knowledge in the discovery processes of modern drugs is gaining ground, as many pharmaceutical companies seek to exploit the unique properties of indigenous herbs that have long been validated by empirical use. This symbiosis of traditional knowledge and modern science not only preserves cultural heritage, but also offers promising pathways for the development of new pharmaceutical products that prioritize efficiency and safety (Anand *et al.*, 2022).

The intersection of traditional knowledge and modern science has also opened the path to significant socio -economic benefits, in particular in the rural sectors where medicinal plants are collected. By establishing a pharmaceutical company, these initiatives can contribute to local economies, enhance communities and promote conservation efforts. Through sustainable collection practices and cultivation initiatives, rural subsistence means have improved while the ecological balance is preserved simultaneously, a fundamental principle of both traditional practices and modern sustainability movements (Khan and Ahmad, 2019).

21.5 Holistic Approachs

In addition, the growing global trend towards natural and holistic therapies has an appropriate time for India to expand its export market for Phyto pharmacies. As consumers all over the world become more attentive to health and wary of synthetic drugs, the demand for natural alternatives is increasing. The ability of India to offer clinically validated Phyto pharmacies rooted both in tradition and in science presents a convincing proposal for international markets (Nooreen *et al.*, 2018). This synthesis of traditional wisdom and contemporary innovation not only enriches the pharmacological repertoire, but also means a wider cultural renaissance in the pharmaceutical that respects the inheritance while embracing progress.

Ultimately, the evolution of phytopharmaceuticals in India exemplifies a vibrant confluence of historical practices and modern progress, which constitutes an integral chapter in the narration of the formulation and preparation of drugs that continues to model the future of the global pharmaceutical industry., The exploitation of natural products in the discovery of medicines emphasizes the integral role that traditional medicinal plants played in the formation of contemporary pharmacological research and development in India. The historical tapestry of Indian medicine, as exemplified in ancient texts, such as Ayurveda and Siddha systems, is deeply woven using plant -based therapies. Ancient Indian doctors recognized the therapeutic potential of various plants, meticulously documenting their properties and uses, which launched the foundations for modern pharmacology and pharmacognosy (Agarwal *et al.,* 2021).

The meaning of plant-derived compounds in the formulation of medicines can be tracked until the formulation of ayurvedic drugs, where a multitude of herbs and botanists was prepared as post (churna), decocations (KADHA) and infusions. For example, the use of Tulsi (*Ocimum sanctum*) for its anti-inflammatory and immunomodulatory properties is proof of the rich knowledge of generations preserved (Bernardini *et al.,* 2018). These traditional practices, emphasizing the holistic health approach, permeated modern pharmacological paradigms that seek to increasingly validate and incorporate these botanical resources.

In contemporary environments, pharmacological investigation of natural products is critical in drug discovery initiatives. The current trend reflects a paradigm shift towards bioprosoperation, in which researchers examine plant species on bioactive compounds that can lead to the development of new therapies. Notable examples include alkaloid isolation of opium papoula (*Papaver somniferum*), which contributed to the synthesis of potent pain anlages and the extraction of compounds such as saffron curcumin (*Curcuma longa*), showing promises in the royal of cancer and anti-inflammatory therapies. In this context, traditional knowledge serves not only as a folklore, but as a scientific basis for pharmacological innovation(Nooreen *et al.,* 2018)..

The interface of traditional medicinal plants and modern pharmacology encapsulates a critical dimension of drug development. It emphasizes the importance of integrating ethnobotanical knowledge with scientific research, promoting a synergistic approach that not only respects traditional practices, but also promotes contemporary pharmaceutical innovation. The powerful combination of historical ideas and modern scientific validation presents an invaluable opportunity for researchers in their search for new therapeutic agents derived from nature., Ayurvedic medicine, an integral part of the Indian heritage, is characterized by its holistic approach to health and well-being, underlining a balance between mind, body and spirit. Among the myriad of formulations that emerged from this ancient system, Chyawanprash stands out as an extraordinary product that has gained traction not only within traditional practices but also within modern clinical contexts. This jam based on herbs, traditionally prepared with a mixture of amla (*Emblica officinalis*), ghi, honey and various other herbs, exemplifies the intersection of ancient knowledge and contemporary therapeutic applications.

The origins of ***Chyawanprash*** date back to the ancient Indian texts, where it is described as a rejuvenated formulation, or Rasayana, designed to improve vitality and immunity. The key historical references include his mention in "Charaka Samhita", an authoritative text on the Ayurveda written by the ancient doctor Charaka, which exposes the formulation as a beneficial for general health, longevity and as a tonic for respiratory and digestive systems. These traditional considerations laid the foundations for its modern adaptations and clinical use(Sharma *et al.,* 2019).

Recent studies highlight the numerous benefits for the health of the formulation, in particular its antioxidant properties. A study conducted by Sharma *et al.* (2019) provides a wide review of various clinical studies that have documented the effectiveness of Chyawanprash to increase immunity and improve physical performance. The main active ingredient, AMLA, is recognized for its exceptionally high Vitamin-C content and has been associated with reductions in oxidative stress, thus suggesting a biochemical basis for the statements found in traditional Ayurvedic texts. Amla's antioxidant ability, together with its ability to modulate metabolic processes, has led to its inclusion in contemporary health regimes, in particular among the populations that try to strengthen their immune system against infections (Subramaniam and Devi, 2020).

In the further clarification of the role of Chyawanprash in contemporary health, a randomized controlled study examined its effects on respiratory health in children, revealing significant improvements in the lung function and a reduction in the frequency of respiratory infections following a regular consumption of the formulation (Sharma *et al.,* 2019). These results exemplify how traditional practices can serve as a precious resource for modern clinical development, offering alternatives based on evidence to conventional pharmaceutical products.

During the Covid-19 pandemic, the World Health Organization (WHO) recognized the importance of integrating traditional medicine in national health systems, reflecting a global pivot regarding holistic health approaches during seizures (WHO, 2020). This change has been particularly relevant in India, where communities have sought family and culturally resonant remedies to manage the psychological, physical and social impact of the pandemic. As observed by Paudyal et al. (2022), the inflection point created by the pandemic acted as a catalyst for greater acceptance and use of traditional medicinal practices among the population. For example, Ayurveda's emphasis on increasing immunity through dietary and lifestyle modifications gained traction, as individuals sought to reinforce their resilience to the disease.

In addition, a remarkable trend has been the multicultural integration of ayurvedic formulations and strategies to deal with COVID-19 symptoms. Ayurvedic practitioners recommended herbs such as AMLA (Phyllanthus nicli) and Tulsi (Ocimum Sanctum) on the premise of their adaptogenic and anti-inflammatory properties, which resonated with professionals and patients (Paudyal *et al.,* 2022). In aligning with traditional practices, there was a considerable emphasis on preventive health measures rather than just in treatment, neglected in western paradigms during challenges of emerging infectious diseases.

21.6 Nanomedicine

Nanomedicine represents a transformative advance in pharmacology, which allows the design and application of drug administration systems to Nanoscale. This technology emphasizes the ability to improve solubility, stability and bioavailability of medicines, which optimizes therapeutic efficacy. In the Indian landscape, the incorporation of nanotechnology within pharmaceutical products has been partly informed by the long -term tradition of using mineral remedies, which often involve complex interactions at the molecular level. For example, the use of formulations of nanoparticles derived from traditional components such as turmeric (curcumin) or neem (sucking indicates) illustrates how historical practices have raided the way for innovative approaches in nanomedicine (Bhakay *et al.,* 2018).

Emerging research highlights the usefulness of biocompatible nanoparticles, which not only provide a directed drug administration mechanism, but also echo traditional health balance concepts as defended in Ayurveda. The ability to manipulate Nanoscala materials has led to the development of liposomes, solid lipid nanoparticles and polymeric nanoparticles, which are instrumental in the effective supply of medicines for conditions such as cancer, diabetes and infectious diseases. For example, studies indicate that nanoparticles loaded with curcumin have demonstrated improved cell absorption and therapeutic effects, which show a fusion of traditional knowledge with avant -garde technology (Bhakay *et al.,* 2018).

Biotechnology also plays a fundamental role in the advancement of drug supply systems by facilitating the development of biological and biosimilar products, which require precise delivery to achieve optimal therapeutic results. The biopharmaceutical industry in India has reflected the traditional practices that prioritize personalized treatments, thus addressing the individual needs of patients through innovations such as monoclonal antibodies and personalized medicine initiatives. The adaptation of biotechnology to create bioconjugated and specific delivery platforms illustrates a continuum of thought that dates back to ancient herbal care practices and patient -centered care.

In addition, the synthesis of biopolymers such as chitosan and alginate, inspired by Indian agricultural practices, not only improves stability and drug release profiles, but also aligns with the cultural spirit of the use of materials of local origin. This trend underlines inherent efficiency and sustainability reflected in traditional methods, which provides a contemporary approach to ecological practices in pharmaceutical development.

The collaboration efforts between academic institutions, government agencies and private sectors in India have further catalyzed this integration of nanomedicine and biotechnology. Initiatives such as the "Make in India" campaign encourage research in nanotechnology and biopharmaceuticals, promoting innovation that is deeply rooted in Indian heritage while adding modern medical care challenges. Through this synergy, the Indian pharmaceutical sector is positioned to develop new medication management systems that not only reflect historical knowledge but also effectively respond to current global health concerns (Bhakay *et al.*, 2018).

21.7 Future Prospective

The areas offered for future research could include the exploration of multi-herb formulations and their synergistic effects, the normalization of plant-based products and the study of the mechanisms underlying pharmacokinetics and pharmacodynamics of traditional drugs. In addition, there is an opportunity for interdisciplinary collaboration that includes ethnobotania, pharmacology and regulatory sciences to promote greater integration of traditional practices in formal medicinal frameworks and to ensure greater accessibility and safety for consumers.

21.8 Conclusion

The colonial era deeply influenced the trajectory of the formulation and the preparation of drugs in India. The interaction of Western medical practices with native methods has led to a complex fusion that has shaped contemporary pharmaceutical developments. By examining this period, it becomes obvious how colonialism not only changed the landscape of health care in India, but also caused a dialogue between traditional and modern practices which continues to evolve today., The post-independence era in India has marked a transformative phase in the country's pharmaceutical landscape, characterized by a progressive but deep transition of traditional plants of modern drug formulations. The impact of political independence in 1947 caused a feeling of nationalism which extended to various sectors, including pharmaceutical products. Before this time, Indian pharmaceutical practice was deeply rooted in the medicine of Ayurveda and Siddha, emphasizing plants based on plants and plants. However, the growing demand for modern medical solutions and the influence of Western medicine have catalyzed a pivot change in drug formulation practices.

To summarize, recognize and respect the contributions of traditional medicine is essential to shape the future of pharmaceutical developments in India. It is clear that the symbiosis between heritage practices and the scientific survey honors not only the historical foundations of medicine in India, but also provides the necessary impulse for innovative progress in the formulation of drugs. The future way requires active collaboration, robust research and political support to guarantee that centuries of traditional knowledge inform and improve the future of medicine.

Traditional practices and modern regulatory requirements is a complex environment for the formulation and preparation of plant -based drugs in India. While modern regulations offer ways to improve control and standardization of quality, the preservation of traditional knowledge and practices remains essential. The balance between innovation and tradition will be crucial because the field of phytotherapy continues to evolve, in particular in the context of an increasingly globalized pharmaceutical market (Mukherjee *et al.,* 2021). The integration of nanomedicine and biotechnology in the development of drug administration systems in India offers a convincing intersection of modern science and traditional practices. The historical context of Indian pharmacological innovations provides a unique background from which contemporary approaches have evolved. Traditional Ayurvedic medicine, with its wide understanding of herbal formulations and specific therapies of the patient, serves as a fundamental element that influences the modern drug administration systems (Bhakay *et al.,* 2018). While the contemporary formulation of drugs continues to evolve, it is imperative to recognize and integrate traditional knowledge systems. Domains such as ethnopharmacology, where traditional drugs are sought for their pharmacological properties, have a fertile land for future exploration and expansion.

The collaboration efforts between traditional practitioners and modern scientists could make significant progress in the efficiency and safety of plant-based formulations, taking advantage of the forces of the two methodologies.

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22

The Role of Indian Knowledge in Development of Natural Products for Pharmaceutical Use

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22.1 Introduction

It is well known that Traditional Systems of Medicine have long played a significant part in satisfying the world's health care demands. They are still doing so today and will play an important role in the future as well. Indian Systems of Medicine refer to medical systems that are believed to be of Indian origin or that have arrived in India from other countries and been integrated into Indian culture. India has the rare distinction of having six recognized medical systems in this category. They include Ayurveda, Siddha, Unani, Yoga, Naturopathy, and Homoeopathy. Though homoeopathy arrived in India in the 18th century, it was fully integrated into Indian culture and enriched, much like any other traditional system (Prasad, 2002).

Ayurveda, an ancient Indian medicinal science, originated from the Vedas, the world's oldest available literature. The Vedas are India's ancient scriptures of wisdom and science. Ayurveda is a comprehensive therapeutic discipline that combines the words "ayu" (life) and "veda" (knowledge). Three important components in Ayurveda are Indian medical science, medicinal herbs/plants and nadi vigyan (pulse diagnostic). Vedic era, natural products have been a common source for the development of novel medications and therapeutic leads. According to recent data, 80% of medication molecules are either natural products or compounds inspired by natural compounds. Nearly half of all approved medications since 1994 are derived from natural ingredients, according to studies on the sources of new pharmaceuticals conducted between 1981 and 2007 (Narayana, 1995).

22.2 Traditional System of Medicine

The medicinal plants are extensively utilized throughout the world in the traditional and modern system of medicine. The two primary streams of India's traditional medical system are the local, folk, or tribal system and the organized Indian system, which includes Ayurveda, siddha, unani, amchi, allopathy, and homeopathy. According to estimates, Ayurveda utilizes 1200–1800 plants, Siddha medicine uses 500–900 plants, Unani uses 400–700 medicinal plants, and Amchi medicine uses 300 plants. Additionally, Indian traditional healers use about 7500 medicinal plants. The use of traditional medicines is expanding quickly as a result of increased interest in them from the public, government organizations, and researchers, as well as the expense and adverse effects of contemporary medications.

In India, **Ayurveda** evolved between 2500 and 500 BC. The conceptual framework of Ayurveda, the science of life, is clear and has remained constant over time. Ayurveda has documented almost 8,000 natural treatments. For instance, Brahmi has been used for about 3,000 years in Indian Ayurveda, and the Charaka Samhita (written around 100 A.D.) suggests using it to treat mental illnesses. Another significant contribution of ancient Indian medicine that is discussed in Ayurvedic writings is Apocynaceae (Sarpagandha). It has been demonstrated that the alkaloid found in this plant's roots works well to treat hypertension. In ancient India, chaulmoogra oil was known to have antileprosy properties (Karunamoorthi *et al.,* 2012).

The eighteen Siddhar, a group of Tamil sages who originated in southern India, are credited with creating the **Siddha** medical system. Siddha medicine was developed during the Indus Valley Civilization and originated in Dravidian culture (Subbarayappa, 2001).

The **Unani** medical system originated in Greece and later evolved in the Arab world. In the eleventh century, unani medicine was brought to India. Another long-standing, well-recorded traditional medical system is **Amchi** or Sowa-Rigpa, which was widely used in areas of China, Tibet, Mongolia, Nepal, Bhutan, and the Himalayan regions (Sen &Chakraborty 2015).

In the 18th century, **homeopathy** arrived in India and became fully integrated into Indian society. It is regarded as a synthesis of Eastern and Western customs. For many members of India's rural and ethnic communities, uncodified folk medicine is also essential to their health care. The knowledge of folk medicine is passed down orally from the ancestors and is not properly documented. Approximately 25,000 potent plant-based medicines and nearly 8000 plant species are employed in traditional medicine. For instance, the Kani tribes of Kerala have utilized Sansevieria lanecolate leaves as a treatment for snake venom (Gurmet, 2004).

22.3 Role of Ayurveda and Siddha in Drug Discovery

Ayurveda and Siddha take a comprehensive approach to health, emphasizing disease prevention, customized medication, and balancing the body's natural energies (Doshas). The principles of Dravyaguna (Ayurvedic pharmacology) and Siddha pharmacology have aided in the discovery of medicinal plant, mineral, and metal-based medications. Ayurveda has made important contributions to modern medicine through its extensive understanding of therapeutic herbs, minerals, and polyherbal preparations (Patwardhan *et al.,* 2004).

22.3.1 Herbal Drugs and Phytochemicals

Many Ayurvedic herbs have resulted in the discovery of bioactive compounds having pharmacological significance:

- **Curcumin** (Turmeric, *Curcuma longa*) has anti-inflammatory, antioxidant, and anticancer effects.
- **Withaferin A** (Ashwagandha - *Withania somnifera*) exhibits adaptogenic, immunomodulatory, and neuroprotective properties.
- **Berberine** (Daru Haridra - *Berberis aristata*) has anti-diabetic, antibacterial, and cardiovascular effects.
- **Reserpine** (*Sarpagandha, Rauwolfia serpentina*) is used to treat hypertension and psychotic illnesses (Vassou *et al.,* 2016).

22.3.2 Polyherbal Formulations

Ayurveda emphasizes **synergistic drug action** through polyherbal formulations, which enhance therapeutic effects and reduce toxicity.

- **Triphala (Amla, Haritaki, Bibhitaki):** Used for digestive health, detoxification, and anti-aging.
- **Chyawanprash:** A classical Ayurvedic formulation with **immunomodulatory** properties (Arun *et al.,* 2014).

22.3.3 Metal-Based and Mineral-Based Preparations

Ayurveda includes **Bhasmas (calcined metals and minerals),** which are processed using specific purification techniques to enhance their bioavailability.

- **Swarna Bhasma (Gold Ash):** Neuroprotective, rejuvenating, and cardioprotective effects.
- **Makardhwaj (Mercury and Gold preparation):** Used as a rejuvenator and immune booster.

Siddha medicine, primarily practiced in Tamil Nadu, is one of the oldest medical traditions in the world. It focuses on **herbomineral formulations**, detoxification processes, and longevity-enhancing therapies.

22.3.4 Application of Siddha Herbs in Drug Discovery

Siddha medicine contains a wealth of botanicals that have been researched for medicinal applications:

Nilavembu Kudineer (*Andrographis paniculata*) has antiviral and immunomodulatory characteristics (used for Dengue and COVID-19). Ponnimaram (*Calophyllum inophyllum*) contains calophyllolide, an anti-inflammatory and wound-healing agent. Karisalai (*Eclipta alba*) provides hepatoprotective and neuroprotective effects.

22.3.5 Herbal, mineral, and metal-based medicines

Siddha treats chronic disorders with a variety of metal- and mineral-based formulations known as Parpam, Chenduram, and Guru Kuligai.

- **Thanga Parpam** (gold-based preparation) is used for rejuvenation therapy and immunological regulation.
- **Muppu** (Universal Salt): A novel Siddha formulation thought to increase medication absorption (Walter *et al.,* 2009).

22.3.6 Siddha Nanomedicine

Siddha writings indicate the use of nanoparticles in medicine long before current nanotechnology. These nano-formulations (Siddha Bhasmas) are highly bioavailable, effective, and long-lasting. For example, muppu formulations have been investigated for their possible use in targeted medication administration (Umrani *et al.,* 2015).

22.4 Discovery of Drugs from Plants

However, the process of finding new drugs from plants is time-consuming and difficult (Fig. 1). The importance of Indian medicinal plants in the global drug development process is the main emphasis of this review. The diseases covered include cancer, metabolic, inflammatory, viral, parasitic, cardiovascular, and metabolic.

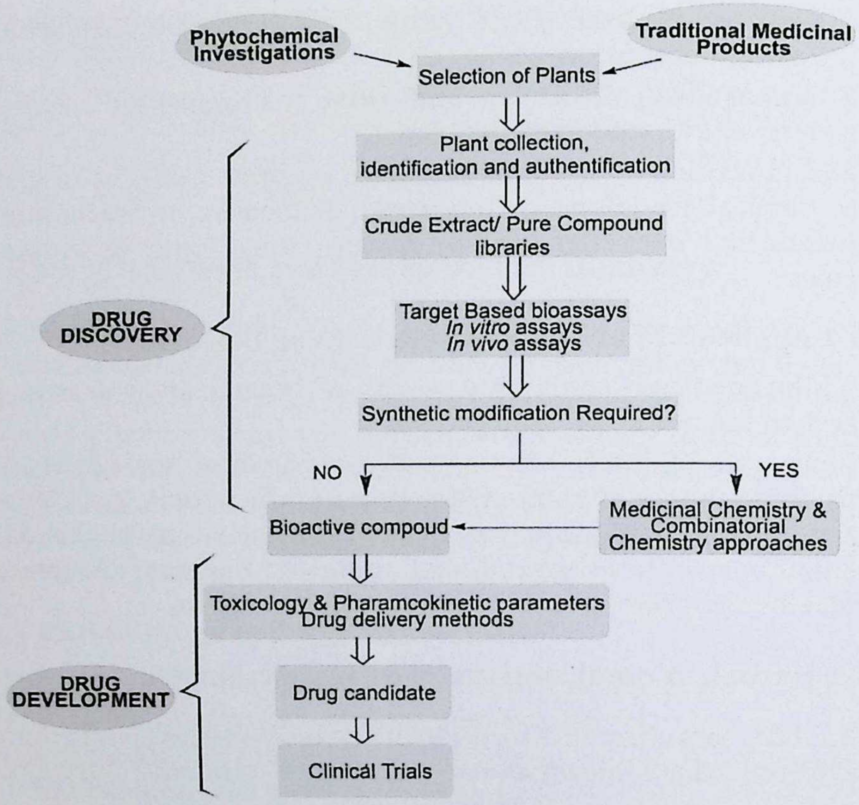
Phytochemical Investigations
Traditional Medicinal Products
Selection of Plants
Plant collection, identification and authentification
Crude Extract/ Pure Compound libraries
Target Based bioassays
In vitro assays
In vivo assays
Synthetic modification Required?
NO
YES
Bioactive compoud
Medicinal Chemistry & Combinatorial Chemistry approaches
Toxicology & Pharamcokinetic parameters
Drug delivery methods
Drug candidate
Clinical Trials
DRUG DISCOVERY
DRUG DEVELOPMENT

Fig. 1: Processofdrugdiscoveryfromplants

22.4.1 Natural Products for Inflammation

One of the major factors causing a lot of disorders is recognized to be inflammation. It has been linked to conditions like diabetes and cancer. NO and pro-inflammatory cytokines (TNF-α and IL-1β) are thought to be the main mediators in inflammatory diseases such as sepsis and rheumatoid arthritis. In order to cure inflammatory illnesses, it is crucial to decrease the production of NO and pro-inflammatory cytokines. Numerous Indian medicinal herbs that are utilized in Ayurveda to treat inflammatory diseases have been shown to contain chemical compounds that, in a variety of in vitro models, decrease the generation of TNF-α and IL-1β (Paul *et al.,* 2006).

Withania somnifera contains withanolides, which are strong regulators of oxidative stress, inflammation, and angiogenesis that have been shown to be effective in arthritis. Their anti-arthritic activity is mainly due to inhibition of NF-B and NF-B-regulated gene expression. Numerous classical Indian literatures mention the use of salai guggal (Boswellia serrata) to cure a variety of inflammatory conditions. According to research done at IIIM, Jammu, this plant contains anti-inflammatory and anti-arthritic properties. The presence of boswellic acids in this plant has been proposed as the cause of the action. Afterwards, it was revealed that boswellic acid inhibited NF-B, COX-2, and 5-LOX (Oh & Kwon, 2009). The most well-known example of a natural anti-inflammatory product is curcumin, which is found in turmeric (Curcuma longa), a common household Indian spice. It was found to be an effective anti-inflammatory agent at CDRI, Lucknow, in 1971. It targets NF-B, COX-2, 5-LOX, TNF-, IL-1, IL-6, IL-8, and MMPs at a molecular level14, exhibiting broad spectrum activity on inflammation. Guggulsterone, found in Commiphora mukul (guggul), is another well-researched natural product from Indian plants (Shishodia & Aggarwal, 2004).

22.4.2. Natural Products for Heart

Cardiac glycosides have been found in a variety of plants. Cardenolides, often known as cardiac glycosides, are steroidal substances having a lactone group attached. They cause intracellular potassium to decrease and serum potassium to rise by blocking the membrane-bound sodium-potassium ATPase pump. As a result, cardiac output rises and heart rate falls due to a decrease in electrical conductivity through the heart tissue (Dziemitko *et al.*, 2023).

According to reports, the yellow oleander plant (*Thevetia neriifolia*) contains the powerful cardiac glycosides thevetin A, B, and peruvoside, which are present throughout the plant and are concentrated in high concentration in the fruits. The antihypertensive properties of Rauwolfia serpentina were initially investigated in India. Reserpine, the active principle, was isolated and investigated outside, nevertheless. Inhibiting monoamine oxidase (MAO) is how it works. In the traditional Indian medical system, Terminalia arjuna bark has been used to alleviate angina-like symptoms. It has been demonstrated that arjunolic acid, which is extracted from this plant, significantly protects the heart in rats with isoproterenol-induced myocardial necrosis (Shaito *et al.*, 2020).

22.4.3. Natural Products for Diabetes

About 41 million Indians suffer from diabetes, a common metabolic condition that has earned the country the title of "Diabetic Capital of the World." Diabetes and related conditions have long been treated with a variety of methods. Perhaps the clearest example is Karela (Momordica charantia), a common home cure for diabetes. This plant's steroidal saponin, charantin, is said to have an insulin-like effect, which accounts for its hypoglycemic impact. Additionally, charantin inhibits the production of glucose in the bloodstream and promotes the release of insulin, indicating that it may have positive effects on non-insulin-dependent diabetes (Krawinkel &Keding 2006).

Andrographolide, a diterpenoid lactone isolated from Andrographis paniculata, has been found to exhibit significant hypoglycaemic activity, and Gymnemic acid IV, which is derived from Gymnema sylvestre (gurmar) leaves, has been reported to show strong hypoglycaemic activity in animal models of diabetes comparable to glibenclamide (Zhang *et al.,* 2009).

22.4.4. Natural Products for Malaria

Malaria has historically been treated with a variety of medicinal plants. These plants have yielded a number of natural compounds with antimalarial properties that have been identified. The anti-protozoal activity of several biflavonoids derived from Selaginella bryopteris against the K1 strain of Plasmodium falciparum has been studied in vitro. The two most potent of them, bilobetin and heveaflavone, with respective IC50 values of 0.3 and 0.26 μM35. The traditional Indian medical system makes extensive use of neem for a number of purposes. It has been determined that this plant's active antimalarial ingredient is nimbolide (Kunert *et al.,* 2008).

Besides,geduninand its dihydro derivativehavebeenfoundtobeactive. Naphthylisoquinoline alkaloidsisolated from leaves of *Ancistrocladus heyneanus*, particularlyancistrocladidine, ancistrotanzanineCand ancistroheynine B have been shown to exhibit significant anti-plasmodial activity with IC_{50} of 0.3, 0.1, and 0.5 μg/ml, respectively (Bringmann *et al.,* 2004).

22.4.5. Natural Products for Cancer

A few Indian medicinal herbs have also been tested for anticancer properties. Arnebin-I, a napthoquinone discovered in *Arnebia nobilis,* has been shown to be efficacious against Walker cancer in rats and P388 lymphoid leukemia in mouse models. A diterpenoid precalyone isolated from *Roylea calycina* has been shown to be active against P388 lymphoid leukemia. Tagitinin F, a germacranolide isolated from *Tithonia tagitiflora,* has also been shown to be effective against lymphocytic leukemia (Gordaliza *et al.,* 2004).

Flavopiridol is a semi-synthetic flavonoid produced from rohitukine discovered in the plant. Dysoxylum binectariferum is the first CDK inhibitor to be studied in clinical trials. Combretastatins discovered in plants of the *Combretaceae* family have purportedly been used to treat cancer. Combretastatin A-4 has been shown to have a significant anti-angiogenic activity, as well as a potent inhibition of tubulin polymerization. *Podophyllum emodii* has a long history of medical use in India, including the treatment of skin cancer and warts. Podophyllotoxin, a lignan derived from this plant, was discovered to be responsible for the anticancer activity.

Tephdidoside, a flavanol glycoside from *Tephrosia candida*, has been shown to be efficacious against human epidermoid carcinoma of the nasopharyngeal. Echitamine chloride, an alkaloid derived from *Alstonia scholaris*, has been shown to cause dose-dependent regression of fibrosarcoma in rats. It has also been shown to be effective against P388 lymphocytic leukemia in a mouse model (Nam, 2003).

Parthenin, isolated from *Parthenium hysterophorus*, has been reported to showcytotoxic activityin human leucocyte chromosomes, erythrocytes of Swiss mice, and cultured bovine kidney cells.

22.4.5.1 Role of Natural Products in Cancer Prevention

Natural substances can be used as an adjuvant therapy to target cancer cells' apoptotic pathways or as a standalone therapy to inhibit cancer cells' self-renewal pathways (Hh, Notch, WNT, and BMI1), hence decreasing tumour relapse and tolerance to chemotherapeutic medicines. (Hh stands for hedgehog, Wnt for wingless-related integration site, and BMI1 for B lymphoma Mo-MLV insertion region 1 homology) (Deep *et al.*, 2018).

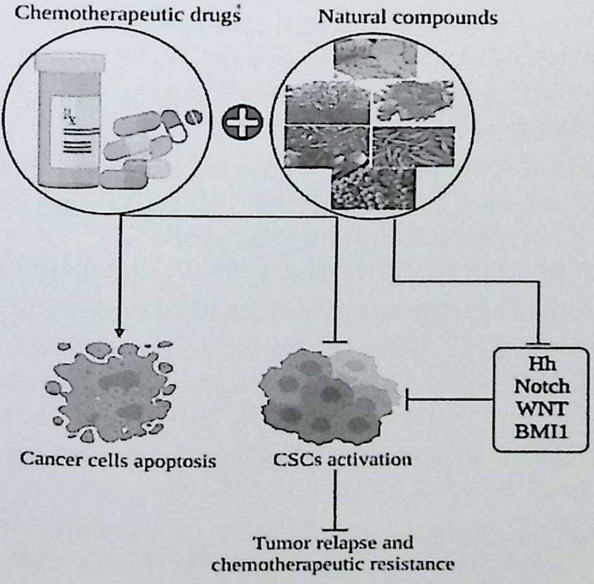

Fig. 2: Natural substances as an adjuvant therapy to target cancer cells.

21.5 Conclusion

Ayurveda and Siddha are valuable assets in India's drug discovery efforts. By integrating traditional knowledge with modern biotechnology, nanomedicine, and pharmacology, India is positioning itself as a global leader in herbal drug development.With strong government support, increasing scientific research, and pharmaceutical industry collaboration, Ayurveda and Siddha will continue to play a key role in drug discovery for chronic diseases, metabolic disorders, and infectious diseases.

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ABOUT THE BOOK

Indian knowledge system includes the vast and diverse knowledge developed over thousands of years across the Indian subcontinent. This wisdom is passed down from one generation to the next, which is an organized way of sharing knowledge, not just of tradition. Indian knowledge system in pharmacy has been used continuously to treat a wide range of illnesses since time immemorial. Additionally, it refers to the study and use of traditional Indian medical practices, mainly derived from Ayurveda, Medical astrology, Yoga therapy, and homeopathic system of medicine. These practices emphasize the use of herbal remedies, holistic health approaches, planet-based remedies and diagnostic techniques described in ancient Indian texts to create modern medications and treatments, frequently incorporating scientific research to confirm their effectiveness in the present. This book provides a quick overview of the many ancient Indian medical systems used for disease diagnosis and their effective treatment in current era.

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